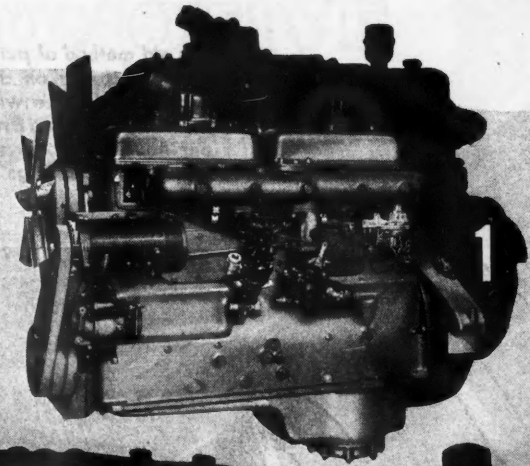
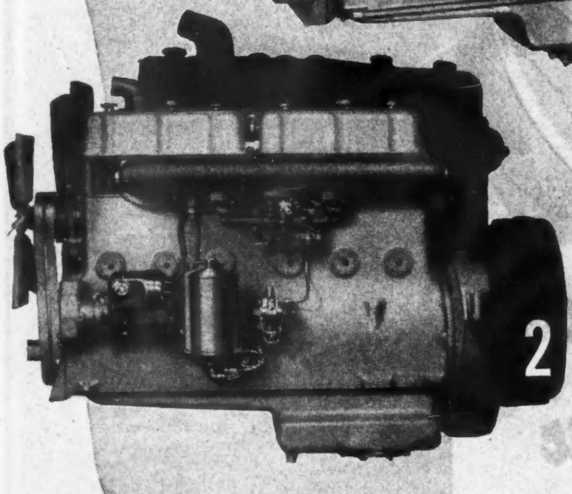
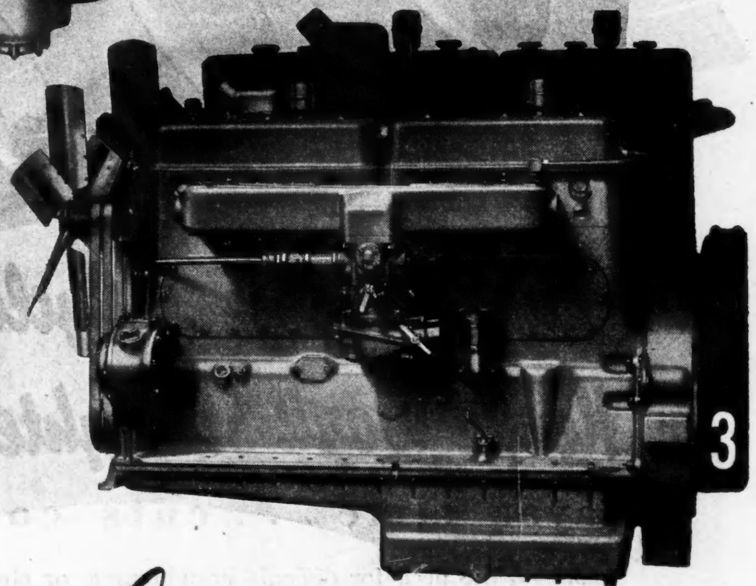
26TH ANNUAL STATISTICAL ISSUE

AUTOMOTIVE and Aviation INDUSTRIES

MARCH 15, 1944







1 Model 140-GK—6-cyl., 4½ in. bore x 5½ in. stroke, 525 cu. in. displ., 137 hp. @ 2100 rpm.

2 Model 145-GZ—6-cyl., 5⅜ in. bore x 6 in. stroke, 817 cu. in. displ., over 200 hp. @ 1900 rpm.

3 Model WAK—6-cyl., 6¼ in. bore x 6½ in. stroke, 1197 cu. in. displ., over 225 hp. @ 1600 rpm.

IN YOUR POSTWAR PLANS *include* WAUKESHA ENGINES

After the war, what will Waukesha Engines be like?

Anything like these? No . . . these three models are wartime engines. Now *all* Waukesha Engines are on war work—one hundred per cent!

But peacetime Waukesha Engines . . . for your every power need . . . *are* in the making. They're already well past the talking stage, but until the war is won, Waukesha postwar engine designs aren't being shown.

They're going to look different, of course. Streamlined . . . modern in every detail of design and construction.

More compact . . . with more horsepower packed into every pound of weight. Lighter, yes . . . but even more rugged . . . and speedier . . . and smoother.

Because they'll be designed and built to utilize postwar fuels to the fullest. For output! And for E-conomy!

Waukesha is going to have a highly specialized line of engines . . . a complete line . . . for every horsepower range.

Right now, Waukesha engineers are working with forward-looking manufacturers in almost every field of power application.

You are invited to consult Waukesha engineers about your engine needs in your postwar plans.

MORE POWER FOR VICTORY

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS. • NEW YORK • TULSA • LOS ANGELES

AUTOMOTIVE and Aviation INDUSTRIES

Published Semi-Monthly

Vol. 90 | March 15, 1944 | Number 6

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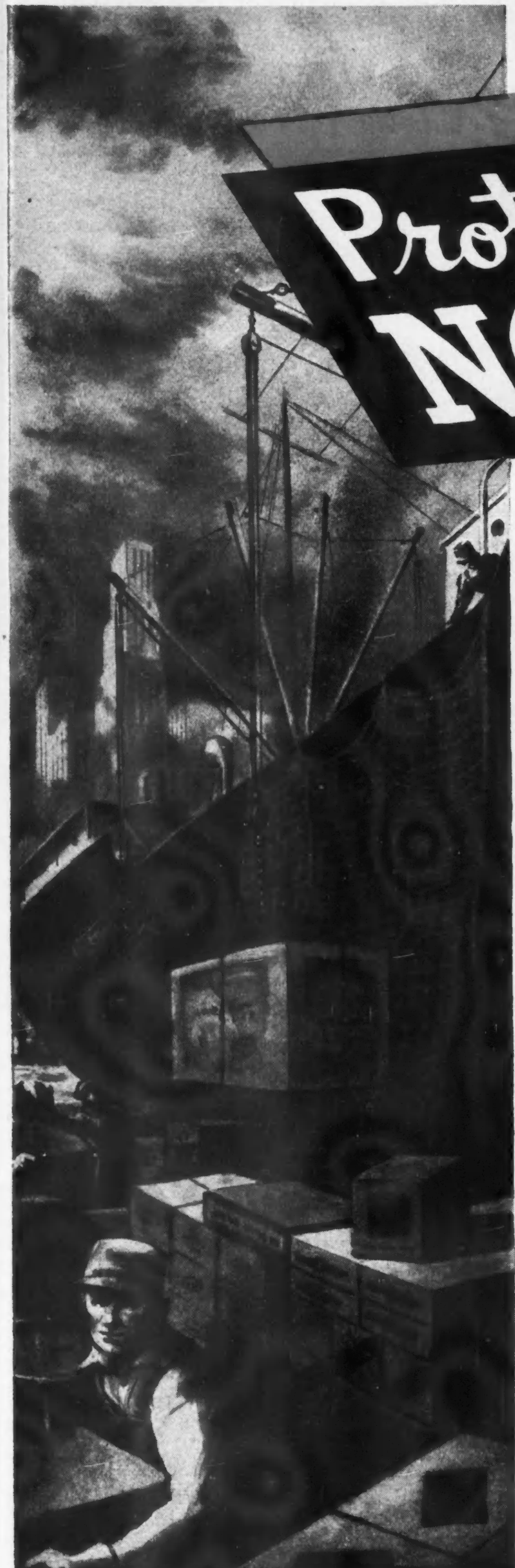

Protected with NOX-RUST

These Parts Will Arrive RUST FREE

Destined for our fighting forces on a tropical battle-front, the parts in these cases must be kept free from rust . . . even in the face of those twin rust creators—sea water and high humidity. They will be—for they are protected with NOX-RUST, the Master Rust Preventive. They would be just as safe from the ravages of rust if they were going to our forces in the Arctic area . . . for NOX-RUST provides *complete, positive* rust prevention. NOX-RUST products meet the Army, Navy and Maritime Commission specifications for rust prevention. Find out now how they can serve you today on your vital war production . . . tomorrow on your products for a better world.

DIP OR SPRAY

WRAP

SEAL

NOX-RUST CORPORATION

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DETROIT 2 • NEW CENTER BLDG. LOS ANGELES 21 • 1817-1855 INDUSTRIAL ST.

The Truck that Barges In from the Sea

NAZI EYES POPPED in awed surprise when they first spotted our Army "ducks"... during the early Sicily and Salerno landings.

What kind of landing "boats" were these ... that kept right on coming ... that seemed to develop "land legs" as they hit the beach and climbed it and kept running at high speed along the roads?

Today, flocks of these "ducks" accompany our invasion forces everywhere ... to deliver the tons of food, water, and gasoline needed during each landing.

Twenty-one Hyatt Roller Bearings carry the load for each of these double-duty trucks ... that "barge" in from the sea.

It takes a bearing like Hyatt to withstand such punishment ... *the terrific impacts of landing and climbing, the churning of the wheels in sand and water.* Only a bearing which has precision, capacity, and toughness can handle these load extremes.

Everywhere in vital war equipment, heavily loaded shafts, gears and wheels do their jobs supremely well when they turn on Hyatt Roller Bearings.

Smooth rolling Hyatts, manufactured with microscopic accuracy, bring easily sustained operation and dependability *not only to fighting equipment*, but also to the machines which help build it.

That's Hyatt's assignment in war and peace ... to serve and save ... to carry on through long hours and adverse weather conditions, extreme speeds and shock loads ... to prolong machine life ... to *keep equipment going!*

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT BEARINGS

DIVISION OF

GENERAL MOTORS


THE SMALLER . . . The Tougher!
Putting lock washers and screws together by hand wastes vital assembly time and increases costs!
Speed-Up Production with Pre-Assembled
SEMS
REG. U. S. PAT. OFF.
FASTENER UNITS
WRITE FOR FREE TEST KIT
Lock washer can't come off but is free to rotate!
GOOD DESIGN DEMANDS MODERN FASTENINGS!
Shakeproof Lock Washers
In a variety of types and sizes.
Shakeproof Cowl Fasteners
"The Quick-opening Lock!"
Shakeproof Thread-cutting Screws
Type 1 for metals
Type 25 for plastics
ARMY E NAVY
SHAKEPROOF inc.
"Fastening Headquarters"
Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS
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Plants at Chicago and Elgin, Illinois
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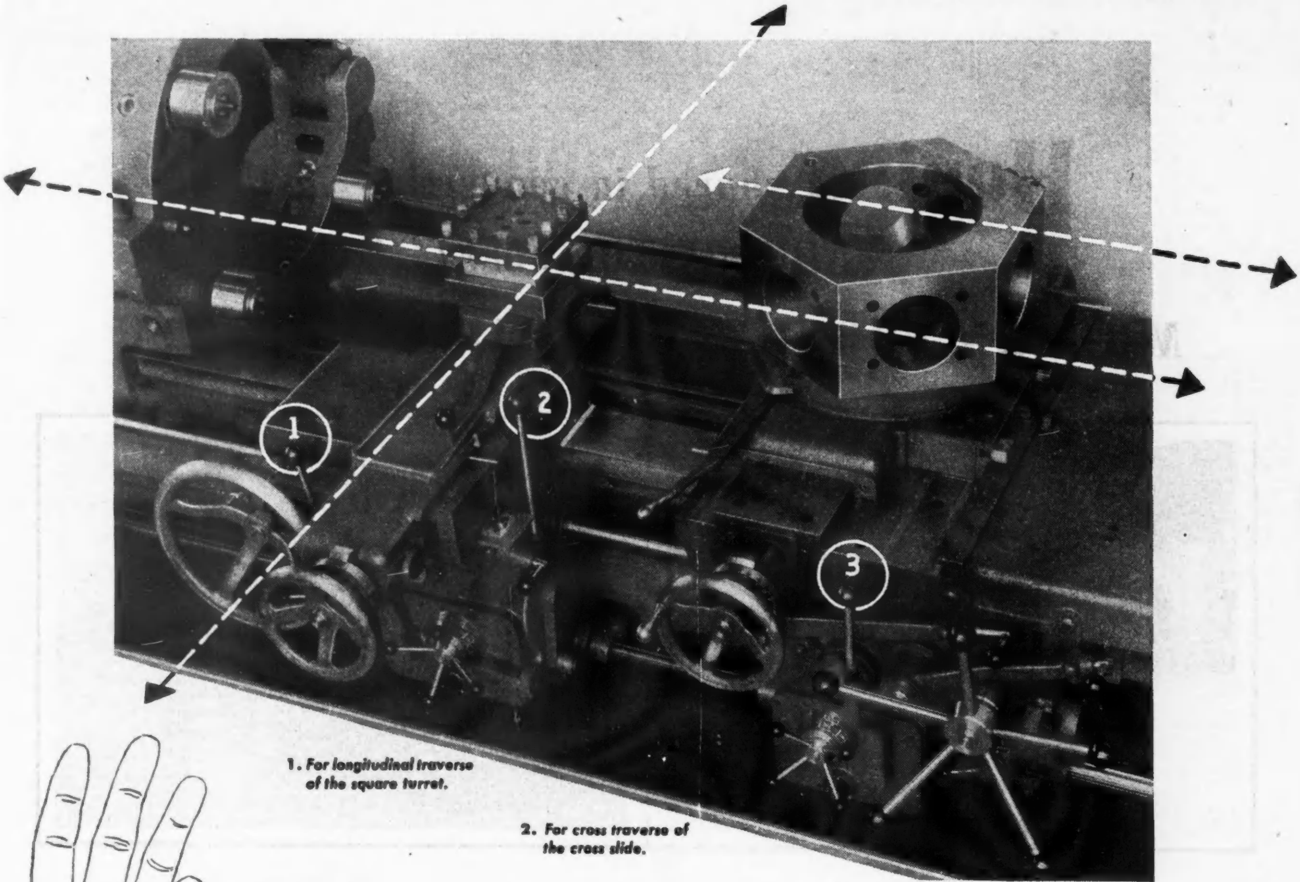
AN EXCLUSIVE GISHOLT ADVANTAGE



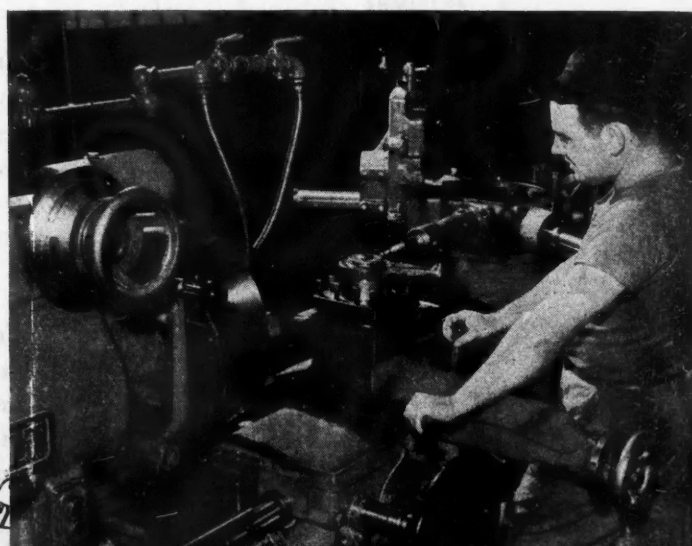
1. For longitudinal traverse of the square turret.

2. For cross traverse of the cross slide.

3. For longitudinal traverse of the hexagon turret.

"3 Way" POWER RAPID TRAVERSE

... aid to war production



There's no half measure about Gisholt's Power Rapid Traverse, provided not only for the longitudinal travel of *both* the square and hexagon turret carriages, but also for the in and out movement of the cross slide. These traverses, standard on Gisholts, bring the tools more quickly into position preliminary to actual cutting operations. They may be operated simultaneously or independently in either direction.

This quicker positioning of cutting tools reduces time between cuts, and conserves the operator's energy for productive work. The potent influence on the day's production of these aids to easy operation is readily appreciated by observing the frequency, ease and safety with which they are used by operators.

Gisholt's *complete* Power Rapid Traverse is but one of many features which speed-up turret lathe operation to increase war production now—and to cut costs afterward.

GISHOLT MACHINE COMPANY

1205 E. Washington Ave., Madison, Wis.

Look Ahead . . . Keep Ahead . . . With Gisholt Improvements in Metal Turning

TURRET LATHES • AUTOMATIC LATHES GISHOLT BALANCING MACHINES


Free
COLORFUL NEW BOOKLET
ON TRANSMISSION APPLICATIONS...
STAMINA!
COTTA
An Assurance of Dependable Service
PRECISION-BUILT • SPECIALLY

THIS surface grinder is sizing breeches for the famous Oerlikon 20-mm anti-aircraft gun firing 500 rounds a minute. The machine operator can grind 1,000 – or 100,000 all alike.

America's chief "secret weapon" is its tremendous manufacturing capacity . . . enough to "bury" our enemies in an avalanche of guns, tanks, planes, ships.

In cutting and grinding operations, *Texaco Cutting, Soluble* and *Hydraulic Oils* are playing their part in the ever-increasing output by American industry.

Texaco Cutting Oils, for example, permit higher speeds and feeds with improved surface finish. They lubricate the tools, and by carrying away heat, prevent chip welding, and lengthen tool life, assuring greater output.

So effective have Texaco lubricants proved that they are definitely preferred in many fields, a few of which are listed on the right.

Texaco Engineers specializing in cutting coolants are at your service through more than 2300 Texaco distributing points in the 48 States.

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ *More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.*

★ *More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.*

★ *More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

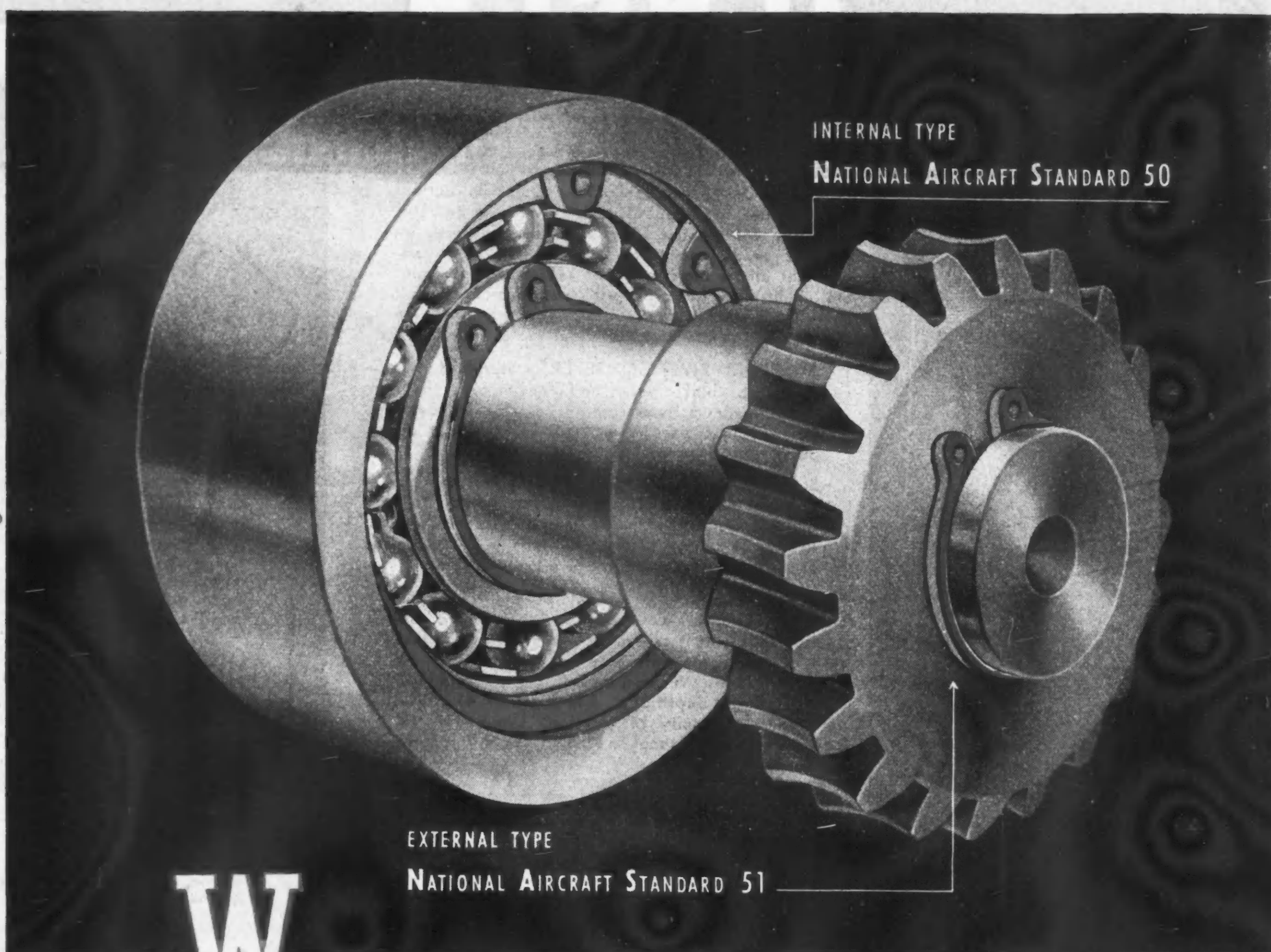
★ *More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.*

★ *More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.*

TEXACO REG. T.M.

TEXACO CUTTING, SOLUBLE AND HYDRAULIC OILS FOR FASTER MACHINING

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT – CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY



Waldes Truarc presents a significant advance in retaining rings. It spreads or contracts without distortion; always retaining its perfectly fitting circular contour. For thrust-load fixing, and shaft and housing applications, Waldes Truarc provides distinct advantages over nuts and bolts or wedges and washers . . . it reduces dimension and weight . . . saves material . . . cuts manufacturing time . . . simplifies assembly and dis-assembly. On request, we will gladly furnish samples and full data for your tests.

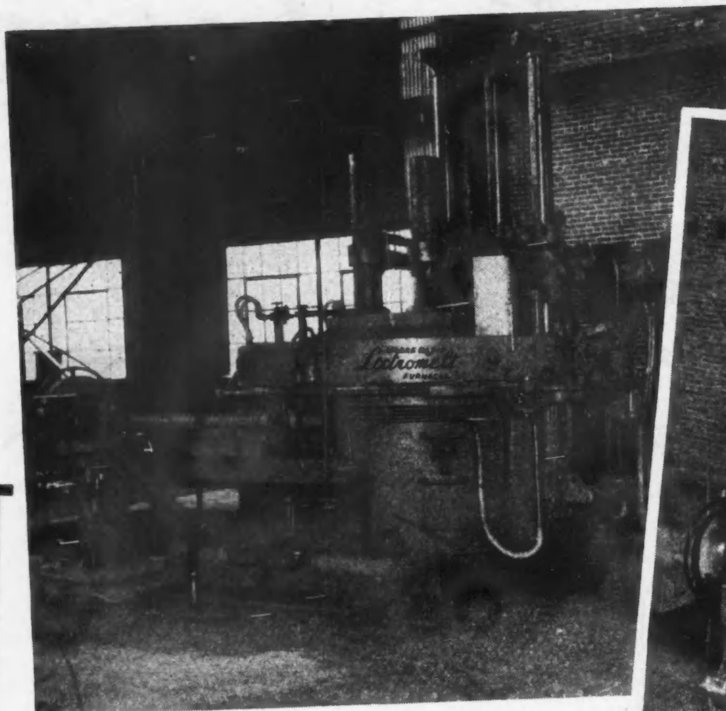
U. S. Patent Re 18144
Sole Manufacturers in U. S. A.

WALDES

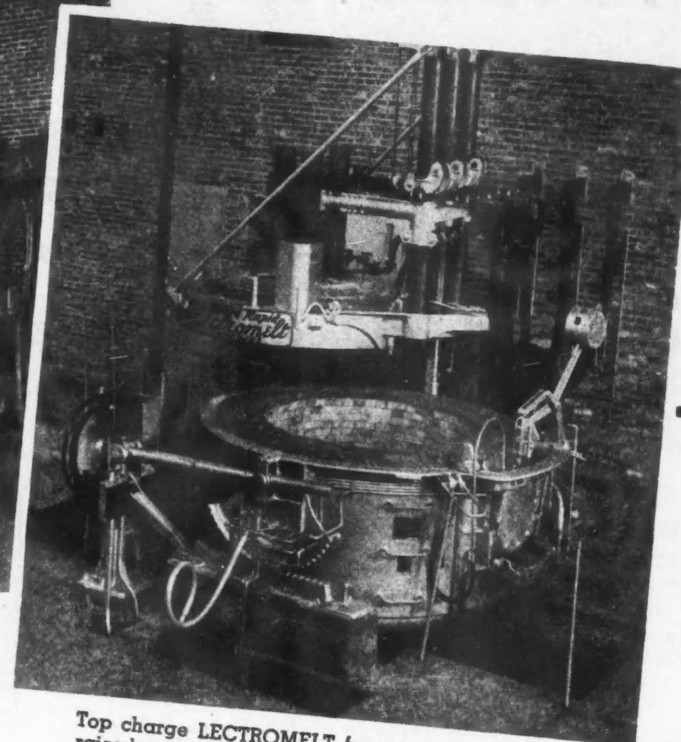
TRU ARC

RETAINING RING

WALDES KOH-I-NOOR-INC. LONG ISLAND CITY-N.Y.



Size "OPT" 4½ tons per hour capacity LECTROMELT top charge type furnace in normal operating position.



Top charge LECTROMELT furnace with roof raised and rotated to one side for quick charging by a drop bottom charge bucket.

Modern MELTING

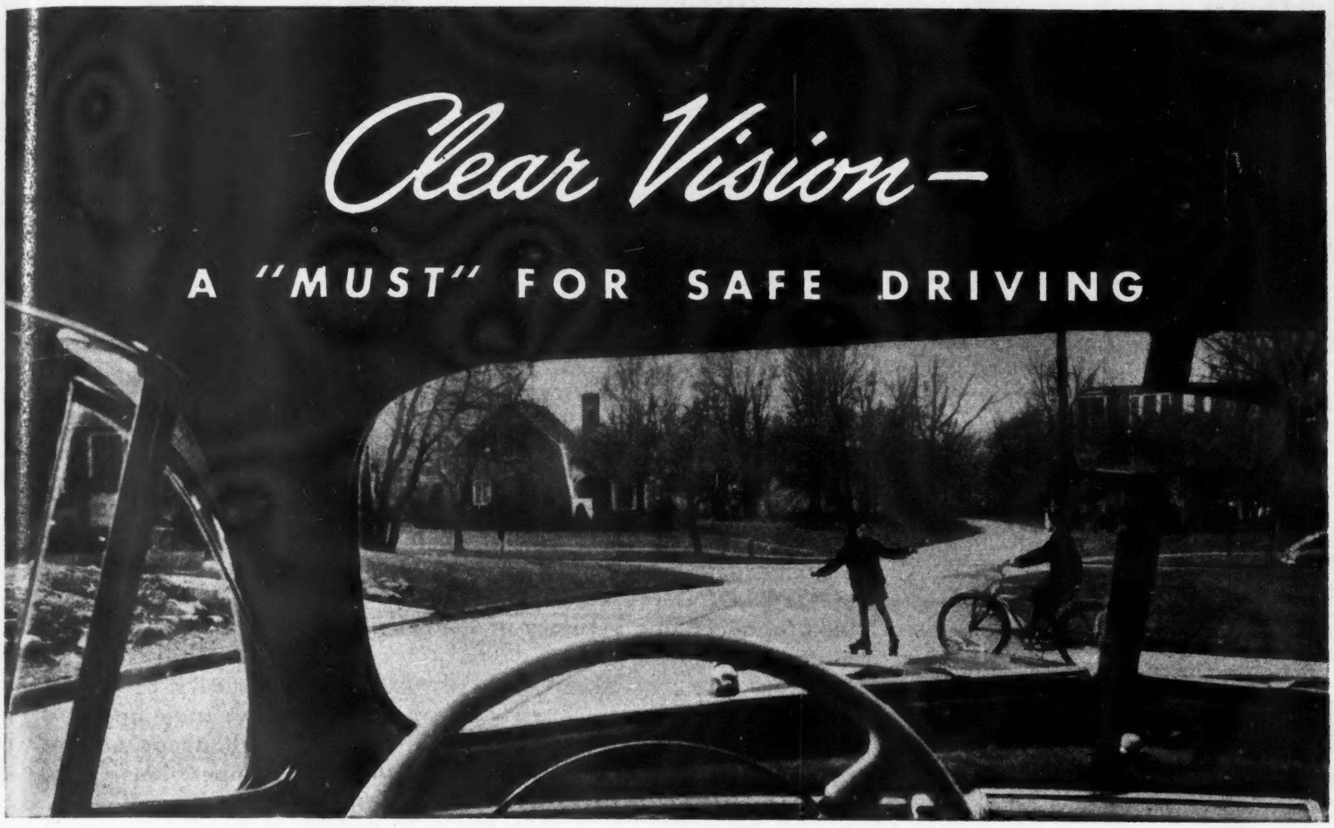
Lectromelt furnaces offer the modern means of handling your melting requirements. LECTROMELT furnaces are used throughout the world for the rapid and economic production of plain carbon and alloy steels for ingots and castings; for the production of gray and malleable irons; for melting copper, monel metal and other products.

The top charge type is built in standard sizes from 100 tons to 250 pounds. Their use results in greater production, lower power consumption, savings in electrode and refractory costs, and increased tonnage per man hour. LECTROMELT FURNACES are ruggedly built for maximum production and long life. Write for complete details.

MOORE RAPID
Lectromelt
FURNACES

PITTSBURGH LECTROMELT FURNACE CORP.
PITTSBURGH, PENNA.

The Furnace of Today and Tomorrow



FOR *GREATER CLARITY...BETTER VISION...*
L·O·F POLISHED PLATE GLASS

HI-TEST L·O·F SAFETY PLATE

Passing cars — jaywalking pedestrians — darting children — these and a thousand other things command the eye's attention while driving. Excessive eye fatigue is a natural result if the eye must compensate for optical distortions.

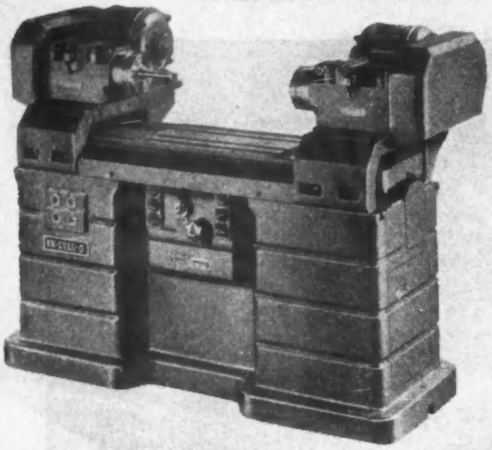
That is why providing Polished Plate Glass — the glass that is clearer, flatter and freer from distortion — is a definite contribution to highway safety.

Libbey·Owens·Ford Clear Vision Hi-Test Safety Plate Glass makes possible maximum clarity of image. The two lights of Plate Glass are ground like an eyeglass and polished like a gem. They are held together by a clear, tough plastic interlayer. Precision is the rule in every step of production.

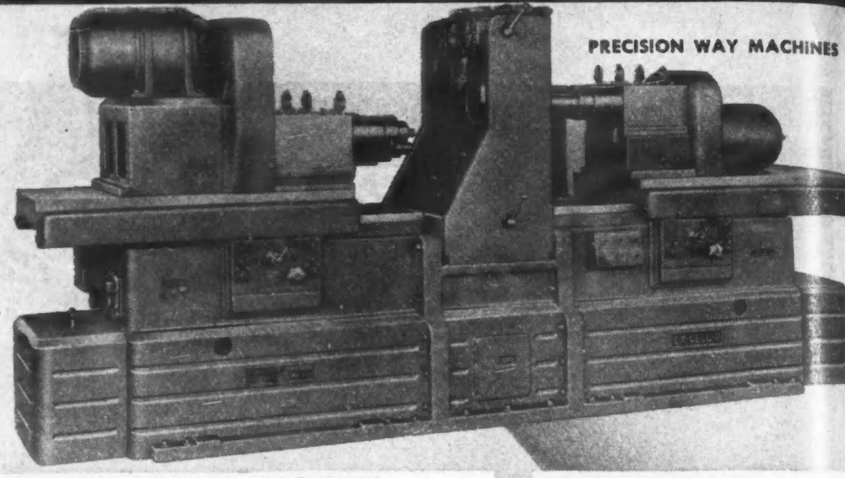
That's why L·O·F Hi-Test Safety Plate Glass has been used as standard equipment in so many of America's cars — for windshields and other openings. And it is good reason for specifying L·O·F Hi-Test Safety Plate Glass for today's replacement jobs and for tomorrow's new designs. Libbey·Owens·Ford Glass Company, 4034 Nicholas Bldg., Toledo 3, Ohio.

L O F
LIBBEY·OWENS·FORD
A GREAT NAME IN *Glass*

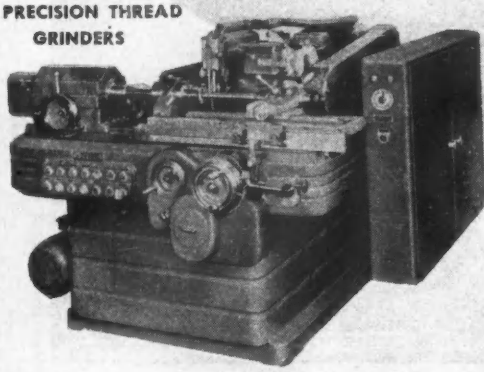
PRECISION BORING MACHINES



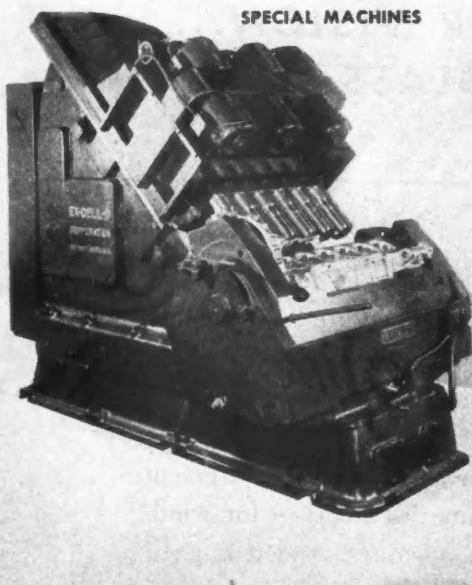
PRECISION WAY MACHINES



PRECISION THREAD GRINDERS

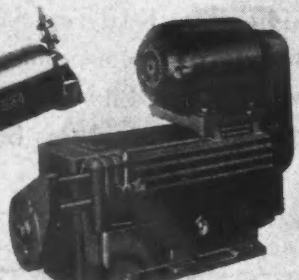


SPECIAL MACHINES



GRINDING SPINDLES

HYDRAULIC POWER UNITS



PRECISION BORING MACHINES

Nine standard styles for boring, turning and facing to extremely close uniform limits with high finish. Hydraulically or manually operated fixtures designed for each job. Machines can be set up for a wide variety of work. Of sturdy construction, they are built for speed and accuracy and simplicity in operation.

PRECISION THREAD GRINDERS

For higher production, greater accuracy and more economy in producing threaded work, Ex-Cell-O precision thread grinders are now universally used by modern industry. Nine standard styles—for external and internal threads—cover the field of today's production requirements.

SPECIAL MACHINES

Ex-Cell-O Angular-type Cylinder Boring machine with six individually adjustable spindles . . . one of many machines designed and built by Ex-Cell-O for specific requirements; often performing numerous operations in one setting and assuring substantial savings in production costs.

GRINDING SPINDLES

Ex-Cell-O manufactures precision ball-bearing spindles for internal, surface and universal grinding machines—as original equipment and as replacement.

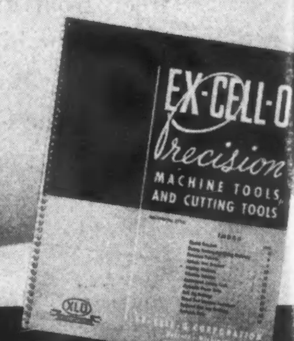
HYDRAULIC POWER UNITS

Left: Provide economical method of drilling, reaming, countersinking and spot-facing—these operations in multiple if desired. Units may be used as prime movers or drivers for other machine units.

PRECISION WAY MACHINES

Ex-Cell-O Precision Way Machines are designed to perform boring, turning and facing operations faster and more accurately—IN ONE SET-UP. One or more fixtures, operated manually or automatically, may be used for simultaneous or progressive operations. The bolted construction feature permits substituting different center sections.

Below: Ex-Cell-O's new catalog on precision machine tools, cutting tools, and other Ex-Cell-O precision products. Contains illustrations, descriptions, and specifications. A copy will be mailed free to any request on business letterhead. Ask for Ex-Cell-O Catalog No. 27121.



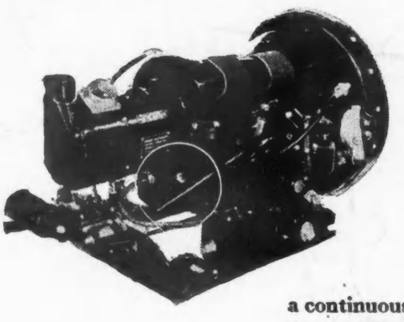
SPECIAL MULTIPLE PRECISION DRILLING MACHINES • GRINDING SPINDLES
PURE-PAK CONTAINER MACHINES • PRECISION PARTS • BROACHES
HYDRAULIC POWER UNITS • R. R. PINS AND BUSHINGS • TOOL GRINDERS

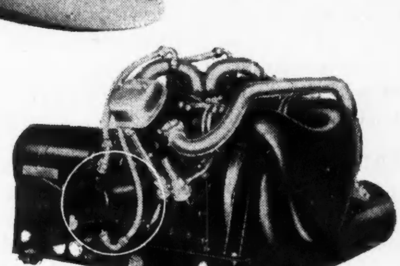
Spark FOR A BOMBER'S NERVE CENTER!

WHERE EVERY OUNCE COUNTS
...ON AUXILIARY POWER PLANTS...WICO IS THE CHOICE

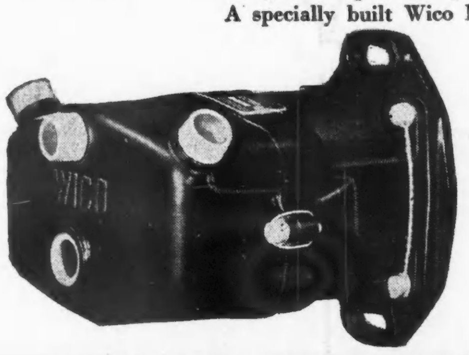
The vital spark for both of the Auxiliary Power Plants illustrated here is supplied by Wico Magnetos. Nowhere is harder service to be found. For these motors are literally eyes, ears, muscles — even lungs — of the giant bombers. They furnish power for starting, radio, turret operation, bomb hoists, heating, and ventilating. They must work in every extreme of temperature — and they must always work.

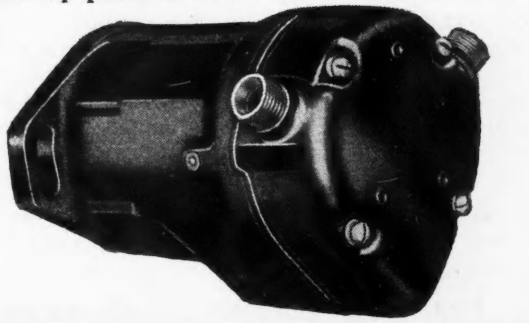
Wico magnetos will come back to their tasks in civilian life, when the war is done, stronger and more adaptable than ever, from the experience they are gaining now in every theatre of war.



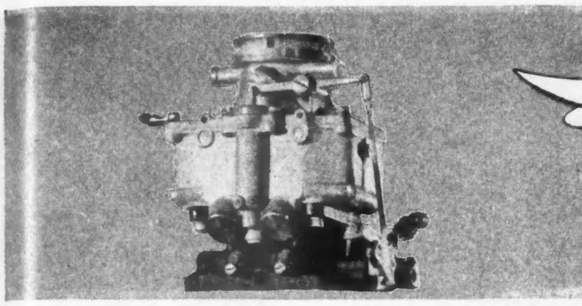


Both the Lawrance "20-A" Aerolectric Power Plant (left) and the Andover Auxiliary Motor (right) conform to the exacting D-2 specifications of the U. S. Army Air Forces. The emphasis is on dependability, compactness, light weight (each of these motors weighs approximately 113 pounds complete). Each has a continuous power output of 5 K.W., an overload rating of 7.5 K.W. A specially built Wico Magneto is standard equipment on both.

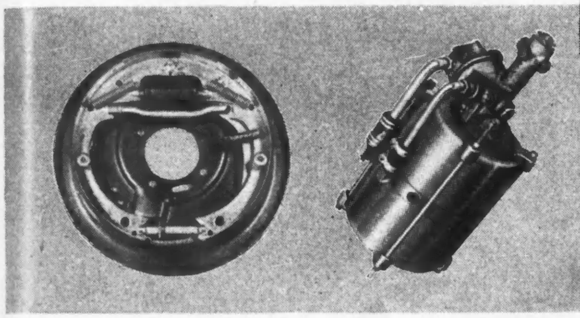




WICO ELECTRIC COMPANY WEST SPRINGFIELD MASSACHUSETTS

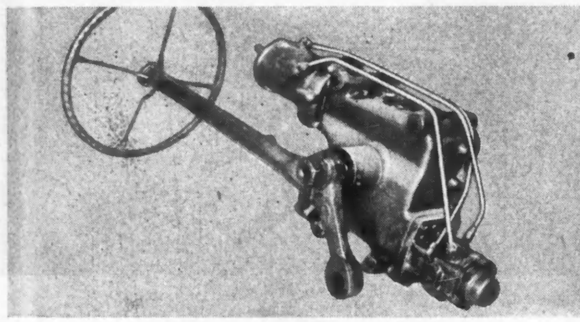


In millions of vehicles, Stromberg* Carburetors contribute to better engine performance.



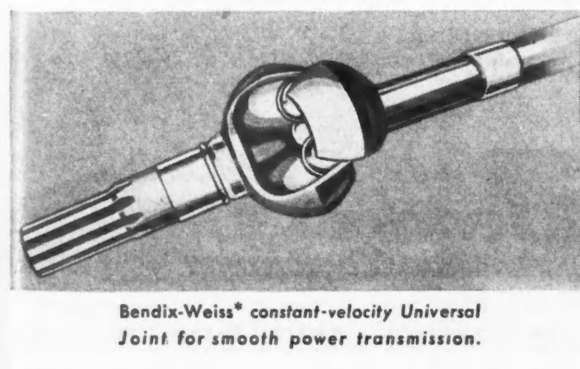
Bendix* Brakes hydraulic and mechanical for safer, smoother stopping.

Hydrovac* one-unit vacuum power braking system for simpler installation and maintenance.



Bendix Hydraulic Power Steering* (illustrated in combination with Ross Steering Gear) replaces muscular effort with hydraulic control.

Bendix* Cleaner cleans automotive parts in record time.



Bendix-Weiss* constant-velocity Universal Joint for smooth power transmission.

A Message to America's

ENGINEERS

The inventive genius of America's automotive and aviation engineers has confounded the Axis and amazed the entire world. Your leadership in providing our armed forces with new and superior weapons—planes, tanks, guns and other supplies—is helping win decisive victories on every battle front.

We here at Bendix have enjoyed working with you in adapting Bendix peacetime products to wartime uses. Like you, we also are looking forward to the day of final Victory and to the privilege of serving you even more effectively than before. Then Bendix* Brakes, Stromberg* Carburetors, Hydrovac* Vacuum Power Brake units and other battle-proved products will be again available for civilian transportation in many new applications calling for dependable performance.

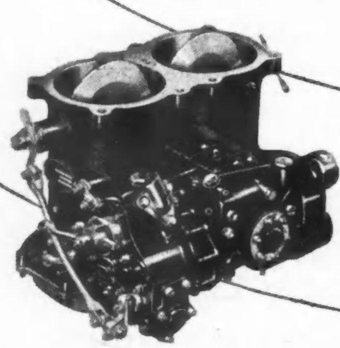
THE INVISIBLE CREW
Precision Equipment by
Bendix Aviation Corporation

BENDIX PRODUCTS DIVISION
SOUTH BEND, INDIANA

THE INVISIBLE CREW: *Stromberg *Carburetors, Bendix* Brakes, Hydrovac* Vacuum Power Braking Systems, Bendix Hydraulic Power Steering*, and Bendix-Weiss* Universal Joints are all important members of "The Invisible Crew"—precision equipment which more than 30 Bendix plants are speeding to world battle fronts.*

** Trademark of Bendix Aviation Corporation.*

TO CARRY FIGHTER PROTECTION *Farther!*



STROMBERG* Injection Carburetor

The Stromberg Aircraft Carburetor is an important member of "The Invisible Crew" . . . precision instruments, and controls, which Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

On the new North American P-51 Mustang fighter planes that escort American heavy bombers to the innermost war centers of Germany, Stromberg* Injection Carburetors help assure the *fuel economy* that makes such long-range missions possible. By compensating quickly and automatically for all changes in speed, altitude, attitude and temperature, Stromberg Carburetors also help to make the Mustang the highest climbing and fastest flying fighter in existence.

**Trademark of Bendix Aviation Corporation*

THE INVISIBLE CREW
Precision Equipment by
Bendix
Aviation Corporation

BENDIX PRODUCTS DIVISION OF BENDIX AVIATION CORPORATION • SOUTH BEND, INDIANA

PRE-DETERMINED *Stopping* POWER

BENDIX* Aircraft Brakes have to withstand the most terrific factory test for stopping power that science has devised!

A massive 30-ton dynamometer in the Bendix laboratory simulates the ground resistance and skidding action that would be encountered in landing a plane on a runway. The 37,500-pound flywheel of this dynamometer, revolving at rim speeds as high as 120 miles an hour, accurately represents the energy which must be dissipated when a given plane is landed. Specially designed, sensitive instruments automatically record the performance of each brake tested.

This scientific method of testing Bendix Brakes is typical of the extreme care with which the performance of all Bendix equipment is *pre*-determined. Thus, Bendix precision manufacture protects personnel and planes in those critical moments of take-off and landing.

THE INVISIBLE CREW
Precision Equipment by
Bendix Aviation Corporation

Bendix* Landing Gear—Bendix Pneudraulic* Shock Struts, Bendix Airplane Wheels, Airplane Brakes, Hydraulic Master Cylinders, and Power Brake Valves are important members of "The Invisible Crew" of precision equipment which more than 30 Bendix plants are speeding to world battle fronts.

**Trademarks of Bendix Aviation Corporation*

BENDIX PRODUCTS DIVISION OF BENDIX AVIATION CORPORATION • SOUTH BEND, INDIANA

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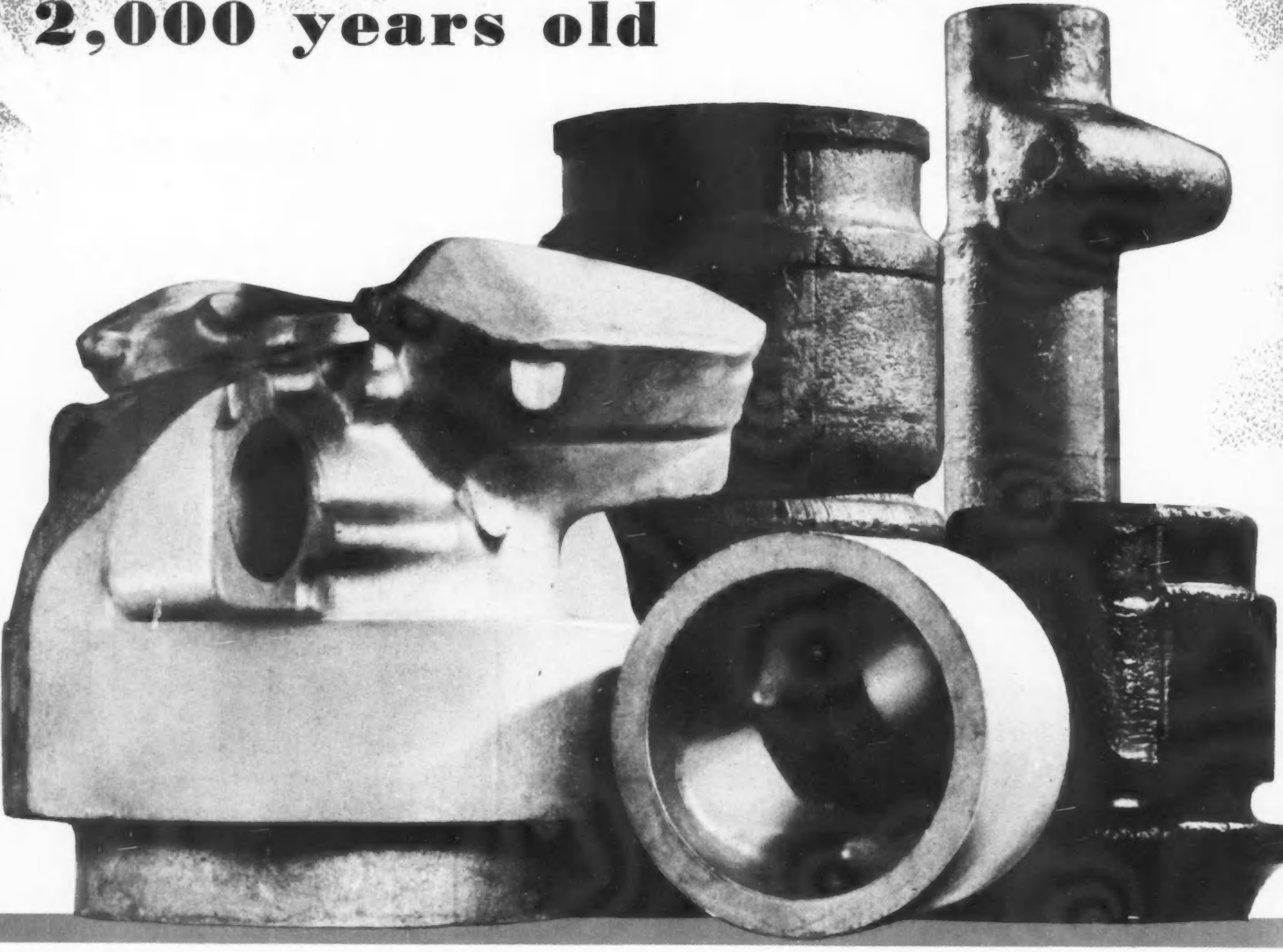
En Route to Action

A Youngster . . .
2,000 years old



● Already old two thousand years ago, forging is still young in its many potential applications. New metals . . . new types . . . new accuracy . . . new economies . . . are all war-proved factors which today have broadened forging's usefulness and potentialities for tomorrow.

Tube Turns, pioneer of many applications, offers engineering and development skills — plus modern production facilities. More important, however, is our willingness to tackle new forging problems with an open-minded, practical point of view.

Development engineers, working on tomorrow's problems, will find Tube Turns' experience invaluable.

TUBE TURNS (Inc.), Louisville, Kentucky

TUBE TURNS *Forgings for Industry*

Mother-ship to the eyes of the fleet, the majestic aircraft carrier speeds onward in artist Sessions portrayal "En Route to Action" . . . presented on the reverse side by Tube Turns.

Lace for a Lady

Those ammunition links represent plenty of American ingenuity and production skill...

In the jungle heat, your armorer loaded the deadly "lace" aboard your P-38. Now, escorting bombers you're headed for a fight.

If your guns jam, you're really in trouble. To minimize this possibility engineers of the Spring Division of Borg-Warner have been hard at work on machine gun and cannon link problems since Pearl Harbor. In cooperation with Army engineers they have developed four new links. They have also had an active part in the Army's program which now produces a .50 calibre link of vastly improved performance. The Spring Division of Borg-Warner produces various size links by the million.

To the making of these precision links and over 100 other war items, we apply the idea that is basic with Borg-Warner: "design it better—make it better."

The automotive and aviation industries have felt the benefits of this idea through every Borg-Warner product. Upon this confidence we hope to build an even closer association in the days ahead.

Partners with the automotive and aviation industries in peace and war, Borg-Warner supplies these and other essential parts . . .

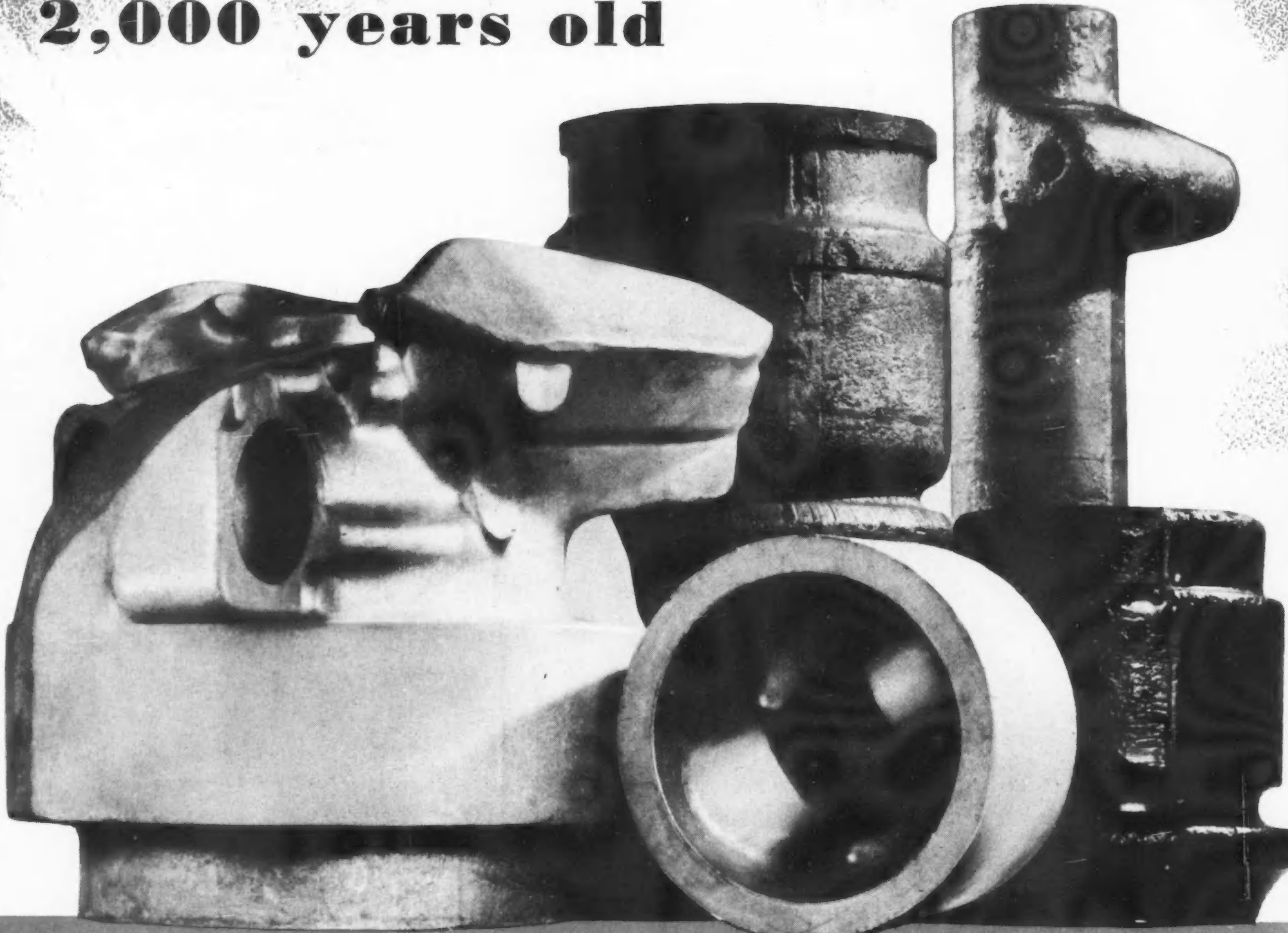
CLUTCHES AND CLUTCH PARTS GEARS
UNIVERSAL JOINTS AND DRIVE SHAFTS
TRANSMISSIONS CARBURETORS
TIMING CHAINS
PUMPS RADIATORS
AVIATION STEEL

ENGINEERING B-W PRODUCTION

BORG-WARNER

Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war: BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • INGERSOLL STEEL & DISC • LONG • MARBON • MARVEL-SCHEBLER CARBURETER • McCULLOCH ENGINEERING • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE • NORGE MACHINE PRODUCTS • PESCO • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR

A Youngster . . . 2,000 years old



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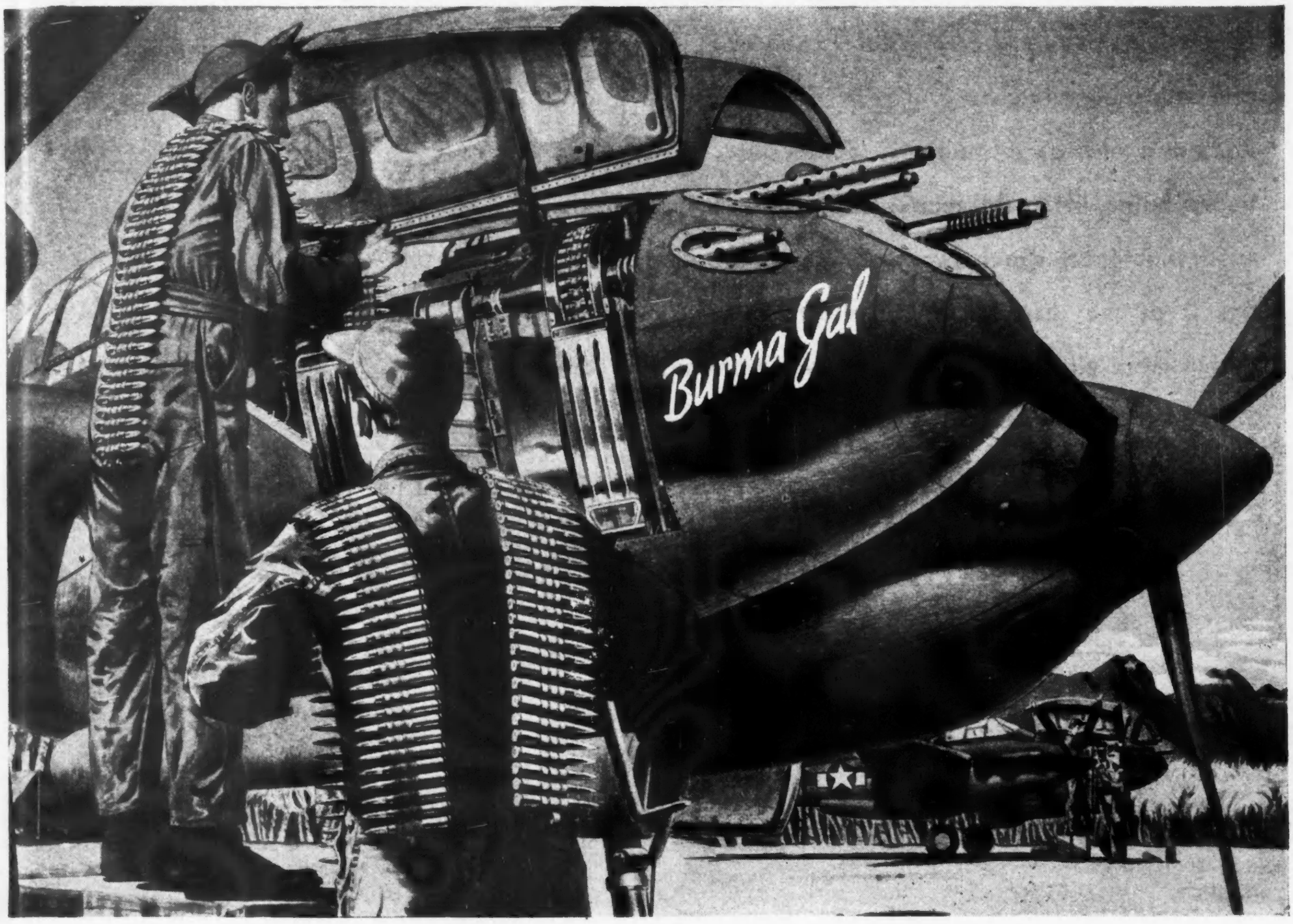

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UNIVERSAL JOINTS AND DRIVE SHAFTS
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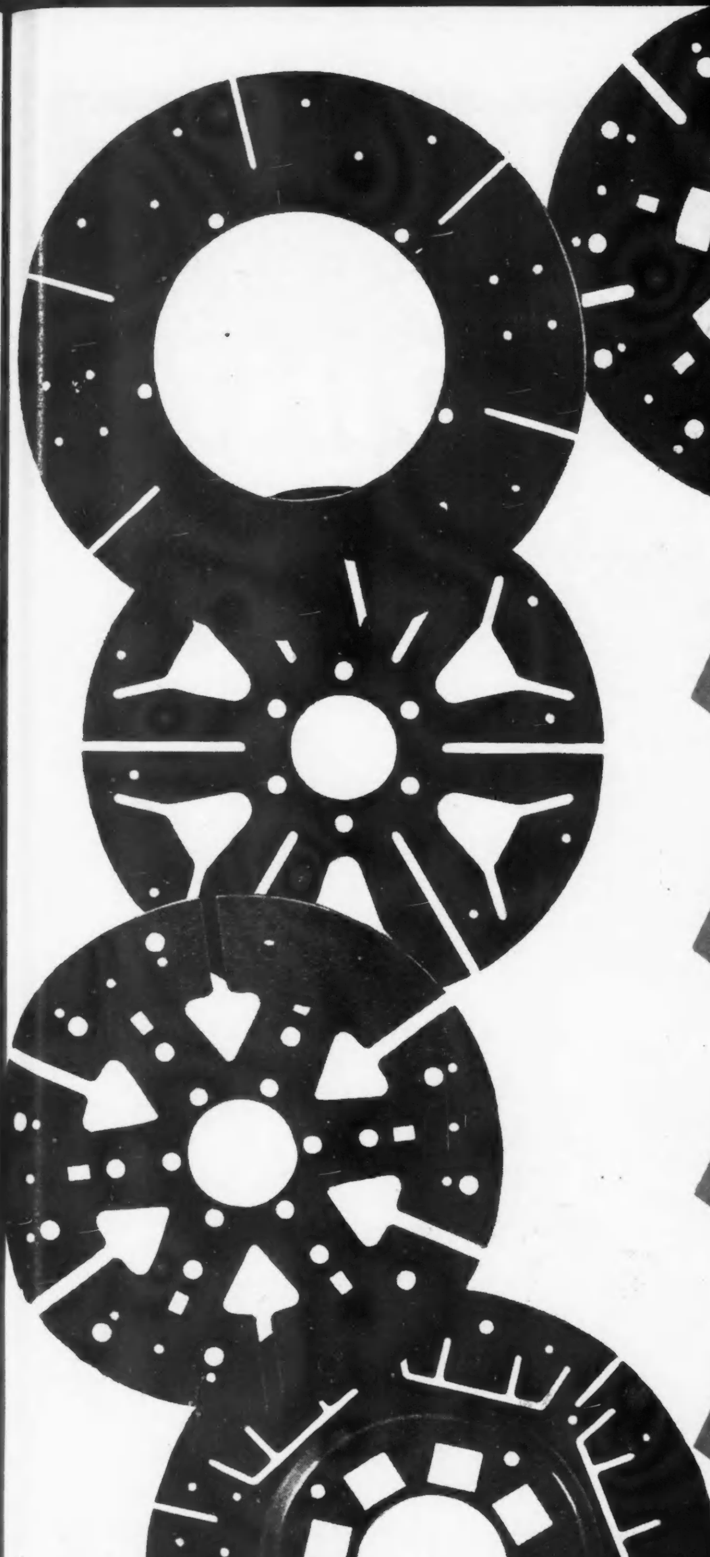


"A Borg-Warner Product"

Just Enough **FLEXIBILITY**

High in **GRIPPING POWER**

FREE *from Splitting Tendencies*

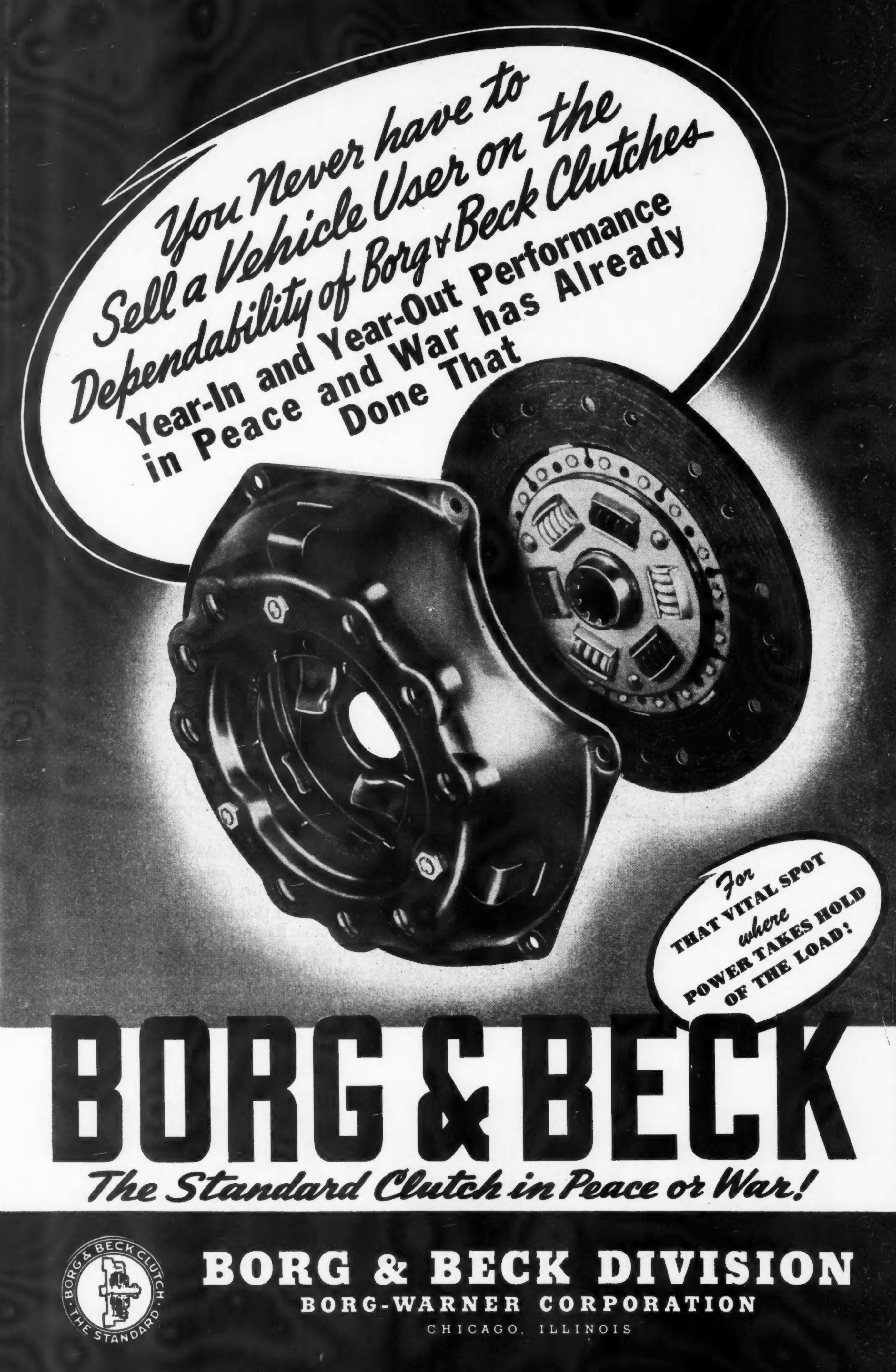
SUPERIOR *in Wearing Qualities*

These advantages are obtained by the use of a special tempered cross-rolled steel known as . . . TEM-CROSS.

Test these Discs in service. Note their pleasing extra smoothness, fine flexibility and long life.

INGERSOLL STEEL & DISC DIVISION
BORG-WARNER CORPORATION
NEW CASTLE, INDIANA
Plants: New Castle, Ind.; Chicago, Ill.; Kalamazoo, Mich.

INGERSOLL CLUTCH DISCS


You Never have to Sell a Vehicle User on the Dependability of Borg & Beck Clutches
Year-In and Year-Out Performance in Peace and War has Already Done That
For THAT VITAL SPOT where POWER TAKES HOLD OF THE LOAD!
BORG & BECK
The Standard Clutch in Peace or War!
BORG & BECK CLUTCH · THE STANDARD
BORG & BECK DIVISION
BORG-WARNER CORPORATION
CHICAGO, ILLINOIS

One of the many types of Sylphon Thermostats supplied to the automotive manufacturer. Extensive engineering facilities available for special designing.

THEY'LL LOOK AT THE WORKS

One of these days—soon we hope—drafting rooms will be working overtime rushing "general arrangements" for new civilian automobiles. Body designers and production men probably will be having their usual arguments—but one thing is certain . . . post-war buyers will look *at the works.*

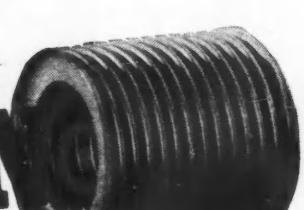
Never before have we, as a people, become so conscious of sound engineering practice. Returning service men will remember the refinements that kept their automotive equipment running under conditions they never thought possible . . . home-front soldiers will recall the troubles they had when their cars were made to run long after they normally would have been traded in.

One of the things that helps to *keep* cars running is the automotive thermostat . . . pioneered by The Fulton Sylphon Co. and improved models will be used to assure the same dependable service in post-war cars. Why not start thinking now about these universally accepted thermostats for your 194X design? Write for Bulletin FB-824.

ARMY E NAVY

TEMPERATURE CONTROLS . . .

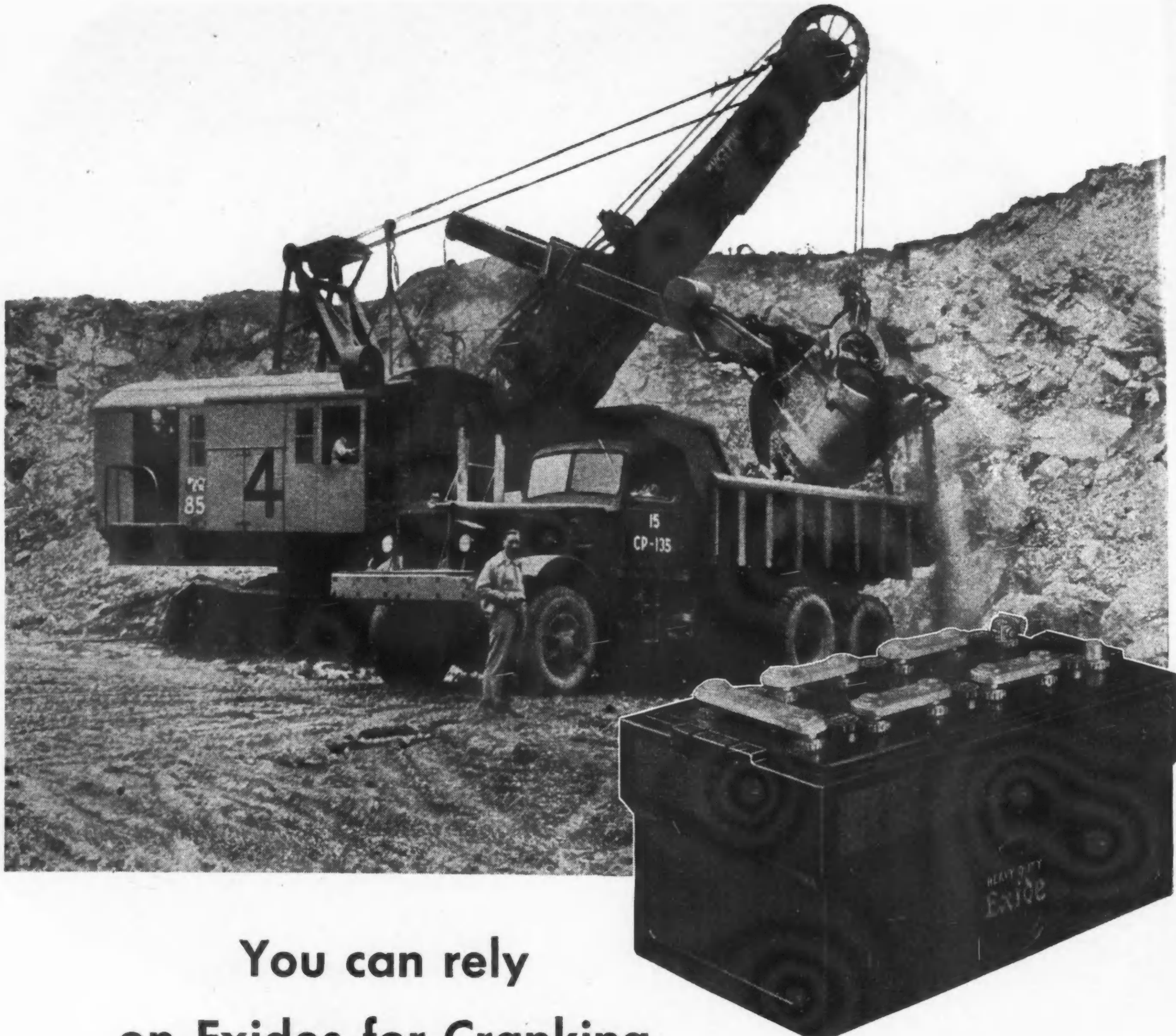
FULTON SYLPHON



BELLOWS . . . BELLOWS ASSEMBLIES SINCE 1904

THE FULTON SYLPHON CO., KNOXVILLE 4, TENNESSEE

Canadian Representatives, Darling Bros., Montreal


4
85
15
CP-135
HEAVY DUTY
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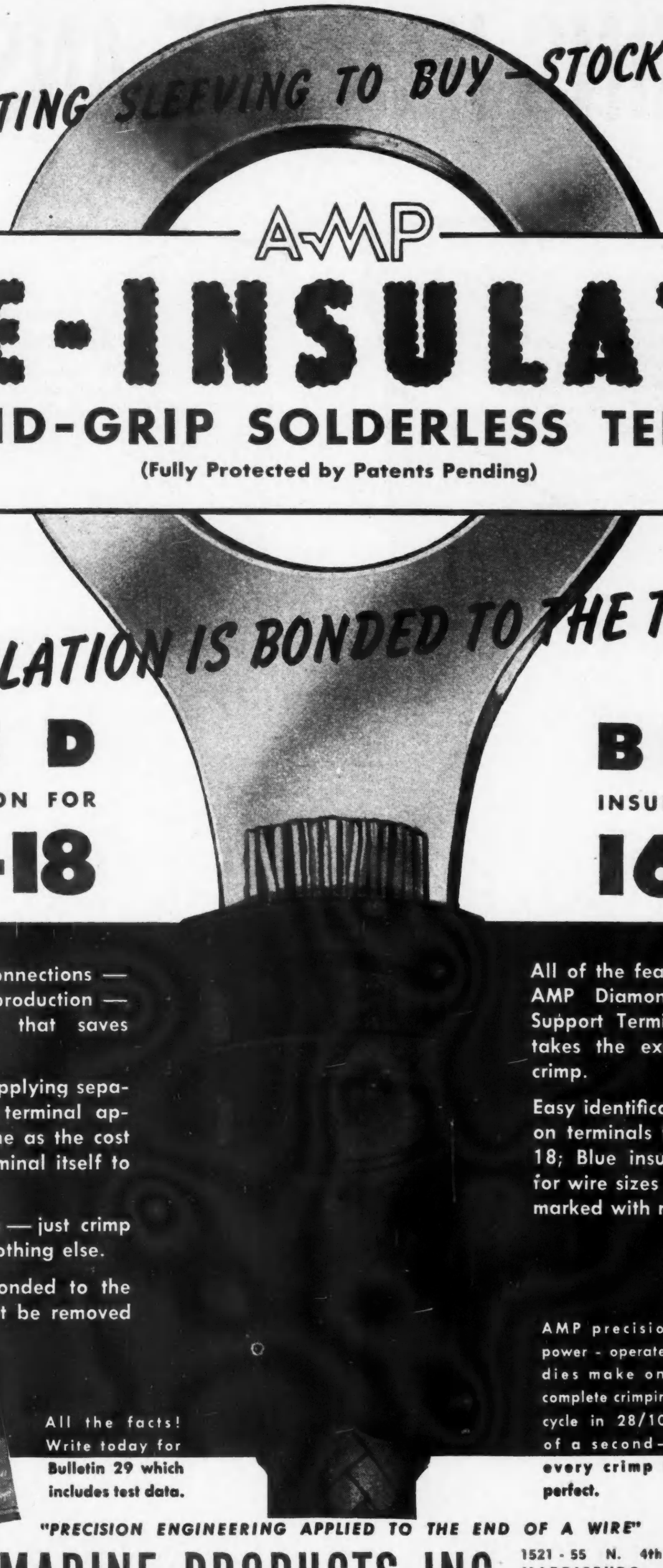
NO INSULATING SLEEVING TO BUY—STOCK—or APPLY



A-MP

PRE-INSULATED

DIAMOND-GRIP SOLDERLESS TERMINALS

(Fully Protected by Patents Pending)

THE INSULATION IS BONDED TO THE TERMINAL

RED
INSULATION FOR
22-18

BLUE
INSULATION FOR
16-14

Perfect solderless connections — designed for mass production — with pre-insulation that saves time, labor, money!

Production cost of applying separate tubing to the terminal approximately the same as the cost of applying the terminal itself to the wire.

Only one operation — just crimp terminal on wire. Nothing else.

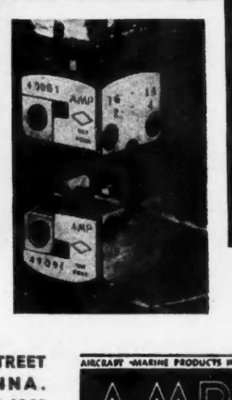
The insulation is bonded to the terminal and cannot be removed accidentally.

All of the features of the famous AMP Diamond Grip Insulation Support Terminal. The insulation takes the exact contour of the crimp.

Easy identification: Red insulation on terminals for wire sizes 22 to 18; Blue insulation on terminals for wire sizes 16 to 14. Press dies marked with matching color.

All the facts! Write today for **Bulletin 29 which includes test data.**

AMP precision power-operated dies make one complete crimping cycle in 28/100 of a second— **every crimp is perfect.**



"PRECISION ENGINEERING APPLIED TO THE END OF A WIRE"

AIRCRAFT-MARINE PRODUCTS INC.
1521-55 N. 4th STREET
HARRISBURG, PENNA.
TEL.: HARRISBURG, 4-0101

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A-MP
SOLDERLESS WIRING DEVICES

A & M ACCESSORIES, LTD., TORONTO, ONTARIO, CANADA

IT'S THE JENKINS CAPLESS TIRE VALVE . . . THE POSITIVE, SELF-SEALING, NUISANCE-FREE VALVE THAT ADDS MILES TO SCARCE TIRES BY MAINTAINING PROPER PRESSURE!

GUARANTEED FOR TUBE LIFE!
Every Jenkins *Capless* Tire Valve is guaranteed Air-Tight for the *life of the tube* to which it is originally attached!

There's never been a time when car owners were so "tire conscious" as they are *right now*. Never a time when Americans were so receptive to *tested* methods of stretching their rapidly aging rubber to its last possible mile. The Jenkins *Capless* Tire Valve, with its road-proved ability to maintain correct tire pressure under every driving condition, is "made to order" for this ready-made market!

Unique in design, the Jenkins *Capless* Tire Valve embodies the "plug-seat" principle long recognized by industrial valve engineers as the simplest, surest method of obtaining a leakproof seal. This plug-type seal is so tight that no auxiliary cap is needed to prevent leakage and keep out dirt. And with no cap to lose ... no core to wear out or loosen ... car owners and service men are freed from a pesky nuisance!

Jenkins *Capless* Tire Valves have been proved on millions of tubes in actual service. Whether you make tubes or market them, you will find it profitable to get the full story from – Tire Valve Division, Jenkins Bros., 80 White St., New York 13, N. Y.

JENKINS *Capless* TIRE VALVE

SEALS AIR IN ▸ ◂ SEALS DIRT OUT

TRADE JENKINS MARK

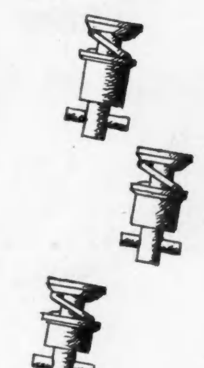
Jenkins Bros MADE BY JENKINS BROS... MAKERS OF FAMOUS JENKINS VALVES


THEN BUSES WILL BE
Braked Electrically
It's rough going along the Alaska Highway — big tractor-trailers heavily laden with supplies for the Aleutians must grind up steep grades, creep down icy hills, or plough through snow and mire. Yet these giant land transports are always kept under safe and complete control by Warner Electric Brakes. Performance-proved on many war fronts—on huge artillery pieces, as well as motor transports — these Electric Brakes are destined for wider ranges of service after the war. Then buses will be *braked electrically* — yes, and many other types of power equipment.
Warner Electric Brake Mfg. Co.
Beloit, Wisconsin
BUY WAR BONDS
WARNER
ELECTRIC BRAKES
CONTROLLED SPLIT-SECOND STOPPING POWER FOR ANY PURPOSE

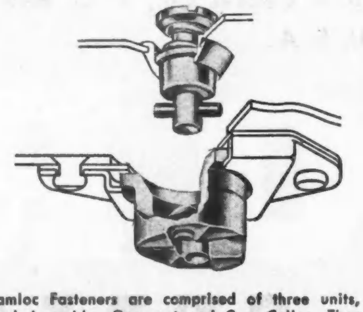
MADE TO THE CLOSE TOLERANCES
SET BY THE AVIATION INDUSTRY
UNBRAKO
Reg. U. S. Pat. Off.
INTERNAL WRENCHING
SOCKET BOLTS
The high degree of precision demanded by the aviation industry is fully met by "Unbrako" Internal Wrenching Socket Bolts. They are being manufactured in our largest department where equipment is of the finest and workers are highly skilled and experienced in making precision aircraft engine parts. These bolts have the famous "Unbrako" qualities of strength and accuracy while due to their internal wrenching feature they facilitate compact designs and save thereby material, weight and cost.
The new "Unbrako" 100° Flush-Head Socket Bolts, unlike ordinary ta-per-headed bolts, are made to most extreme accuracy.


FOR ACCURACY
. . . FOR STRENGTH
. . . FOR SAFETY
Knurled "Unbrako" Socket Head Cap Screws
The knurled heads prevent time-wasting finger slip and lost motion—help speed production. Knurling also permits locking after countersinking. Sizes: No. 4 to 1½" diameter.
"UNBRAKO" Self-Locking Hollow Set Screws with the Knurled Points
Maintenance, time and money savers. When tightened as usual, the knurls dig in and lock the screws in place so they positively won't work loose under vibration. Sizes: No. 4 to 1½" diameter.
PAT'D and PAT'S PENDING
"UNBRAKO" Knurled Socket Head Shoulder Screws
are precision ground . . . are extensively used in many places. Great variety of sizes immediately available from stock.
STANDARD PRESSED STEEL COMPANY
BOX 611 JENKINTOWN, PENNSYLVANIA
BOSTON · DETROIT · CHICAGO · ST. LOUIS · INDIANAPOLIS · SAN FRANCISCO
OVER 40 YEARS IN BUSINESS
Knurling of socket screws originated with "Unbrako" years ago.

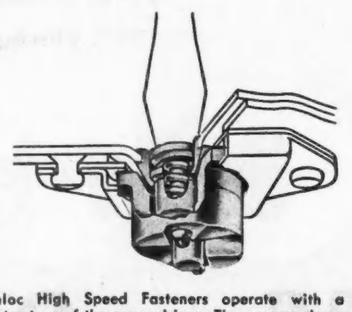
WARPAGE?



Warpage presents no problem to the many aircraft manufacturers who secure their doors and access panels with Camloc High Speed Fasteners. Camloc's patented stud assembly with its permanent cross pin is securely retained in the removable panel. Yet it can be quickly installed or removed as a unit. This permits individual selection for size at time of final assembly. Camloc's unique spring construction allows the stud an unusual range, giving complete coverage of grip thicknesses with a minimum number of stud lengths. When the needs of war no longer demand our entire production, an ever increasing list of industries will use Camloc fasteners. Write for catalog.



Camloc Fasteners are comprised of three units, Stud Assembly, Grommet and Cam Collar. They are four to ten times faster in installation than similar devices.

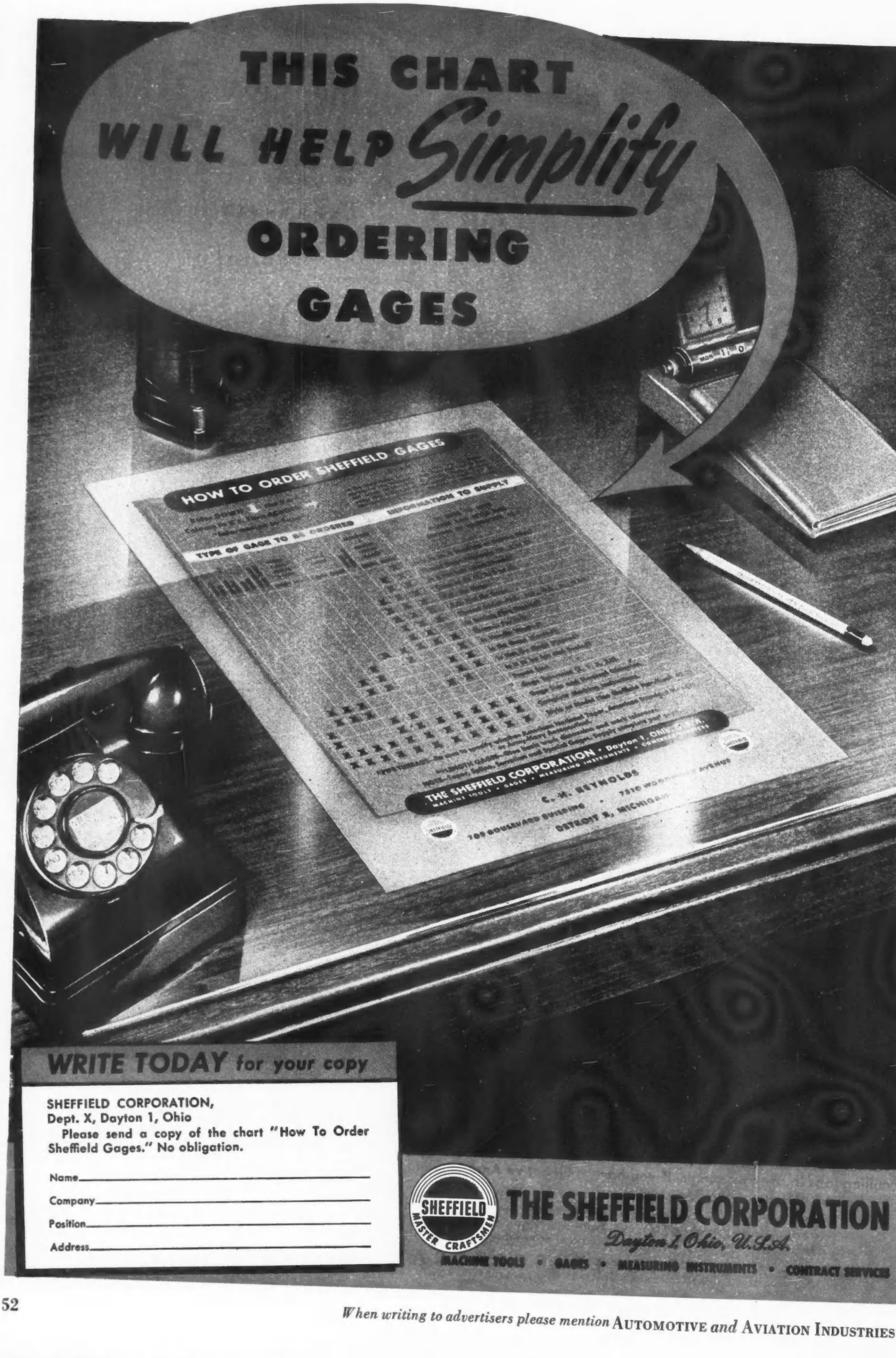


Camloc High Speed Fasteners operate with a quarter turn of the screw driver. They secure doors and access panels in metal, plastic and plywood.

CAMLOC *high-speed* **FASTENERS**

CAMLOC FASTENER CORPORATION, 420 Lexington Ave., New York 17 — 5410 Wilshire Blvd., Los Angeles 36


BONDED TO SHELL
The sealing element in Victor Oil Seals is moulded to exact dimensions and permanently bonded to the metal shell. No clamping device is needed to prevent the element rotating with the shaft. There can be no leakage through the structure of the seal. The sealing element is always concentric to the shaft.
AN EXCLUSIVE VICTOR FEATURE
PATENTED
Experience with Victor Oil Seals in trucks, tanks, Jeeps, guns and airplanes, under wartime conditions, further confirms the unusual oil, heat and age-resisting characteristics of this great Victor product, already proved in peacetime operations.
Victor Manufacturing & Gasket Co., P. O. Box 1333, Chicago, Ill., U. S. A.
VICTOR
GASKETS . . . OIL SEALS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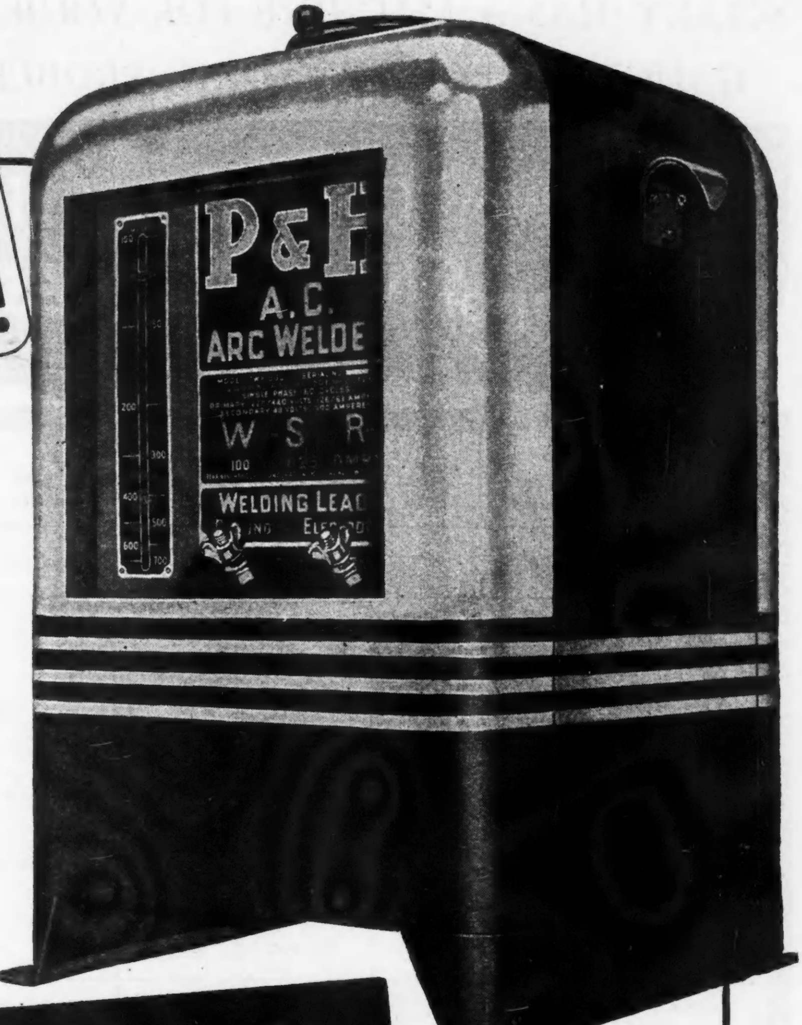
MACHINE TOOLS • GAGES • MEASURING INSTRUMENTS • CONTRACT SERVICES

P&H
— AC —
ARC WELDERS

WELD

from 15% to 30%

FASTER!



14 MODELS CAPACITIES UP TO 1200 AMPS

Swifter Production

Liberal capacity permits use of larger electrodes. Easier control of molten pool enables you to weld from 15 to 30% faster—makes shorter work of all kinds of jobs, including intricate, close-corner welding.

Easier Operation

Micromatic adjustment gives you an infinite number of settings. One single creep-proof control provides stable current that "stays put" where you want it.

WSR (Welding Service Range) Ratings

Every model carries a WSR rating plate which specifies actual *usable* welding range from minimum to maximum. There's no guesswork.

Greater Values

Quality-built to last for years. No rotating parts to wear. Maintenance costs are practically eliminated. Write for complete information on P&H A. C. Arc Welders. Models up to 1200 amperes capacity. *Ask also about P&H Electrodes for A. C. Welding.*

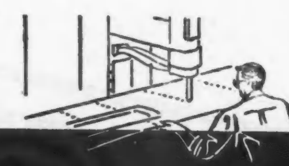
P&H is America's only manufacturer providing a complete welding service including A. C. and D. C. Arc Welders, Welding Electrodes, Welding Positioners, Electric Hoists, Overhead Cranes, Etc. Write for Literature.

Gen. Offices: 4559 W. National Ave., Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION
ARC WELDERS • EXCAVATORS • ELECTRIC CRANES P&H MOTORS • HOISTS • WELDING ELECTRODES

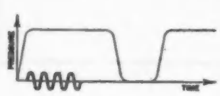
Canadian Distribution: The Canadian Fairbanks-Morse Co., Ltd.

SCIAKY HAS A MACHINE FOR YOUR LIGHT GAUGE FERROUS WELDING PROBLEM . . .

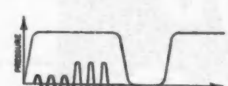


Wherever Consistent, High Shear Value Spot Welds are *ESSENTIAL*

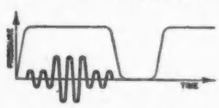
TYPE	KVA RATING	THROAT DEPTH	WELDING RANGE	SPEED S/M - THK.	MAX. PRES. 90% AIR	SPECIAL FEATURES (SEE BELOW)	MATERIALS
PMCO.1-11 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	1	Monel Metals, Mild, corrosion-resisting zinc-coated steels
PMCO.1-12 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	2, 4, 6	Same as PMCO.1-11 plus: ordinary black & high tensile steels
PMCO.1-13 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	3, 4, 5, 6	Same as PMCO.1-12 plus: some air-hardening & chrome-molybdenum steels
PMCR.1-3 ROCKER ARM	60	24"	.020-.090	180 - .032	2600	1	Same as PMCO.1-11 plus: Pickled Steels
P-1-R PORTABLE	90	*	.020-.080	*	*	1	Same as PMCR.1-3
PMCO.2 PRESS TYPE	190	34"	.032-.250	80 - .064	4000	2, 4, 6, 7	SAME AS PMCO.1-13
PMCO.2-1 PRESS TYPE	190	34"	.032-.250	80 - .064	4000	3, 4, 5, 6, 7	SAME AS PMCO.1-13
PMM.2-1 SEAM WELDER	700	34"	.020-.064	400 - .040	2140	1	Monel metals, low carbon & corrosion resisting steels



1. WELDING CURRENT ONLY



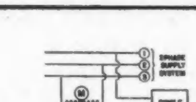
2. PREHEATING AND WELDING CURRENT



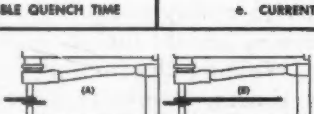
3. PREHEATING, WELDING AND ANNEALING CURRENT

4. VARIABLE PRESSURE

5. ADJUSTABLE QUENCH TIME



6. CURRENT DIVIDER



7. ENERGY COMPENSATOR

These a.c. machines are specifically designed for the welding of light gauge steels. They deliver the high pressure and precise currents necessary in welding structures subject to stresses and vibration. Wherever high quality welds and fast, dependable operation is the requirement, you will find a Sciaky welder to solve your problem.

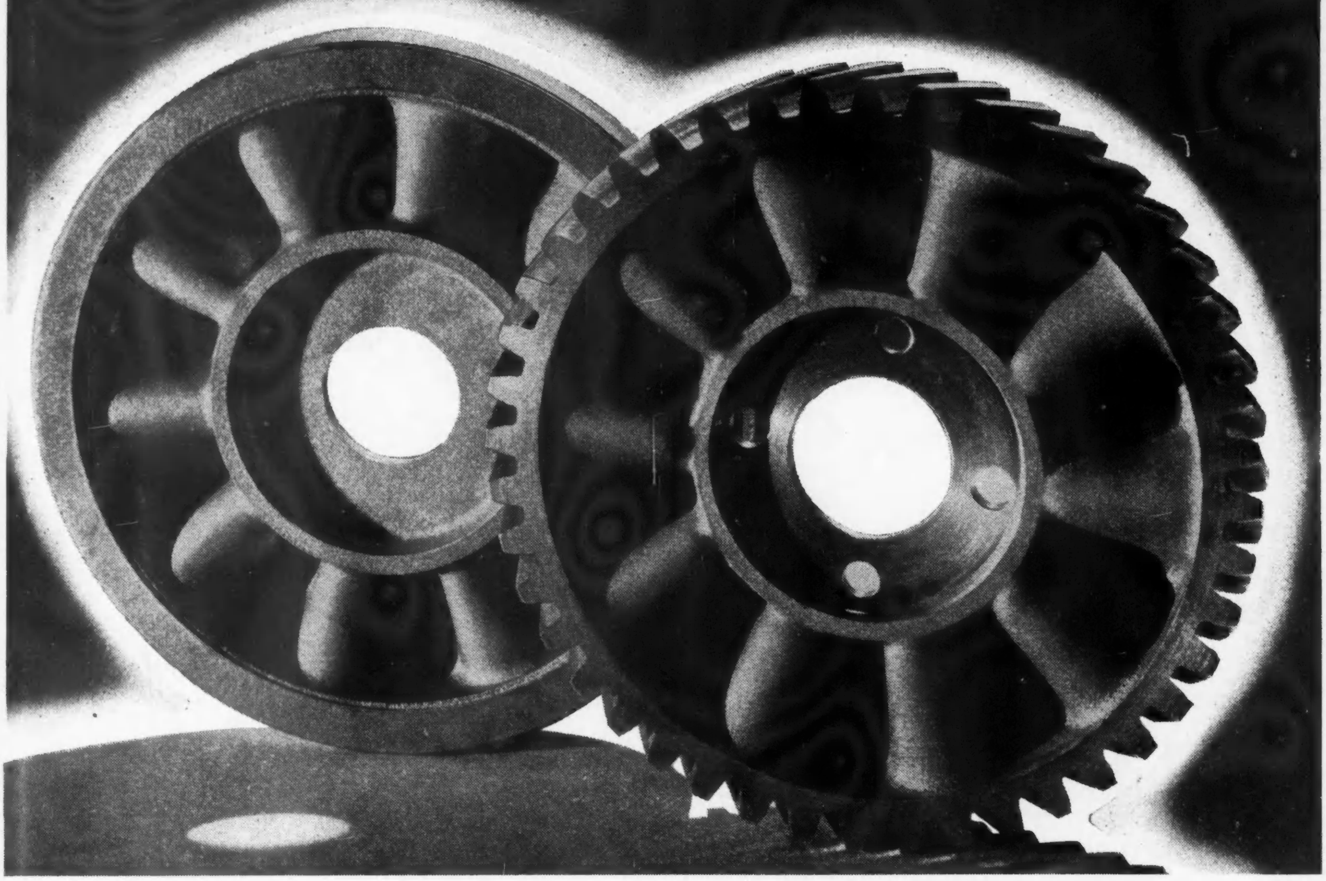
PMCO. 1-11

SCIAKY BROS.

Manufacturers of a Complete Line of A.C and D.C Electric Resistance Welding Machines

4915 W. 67th Street, Chicago, 38, Illinois

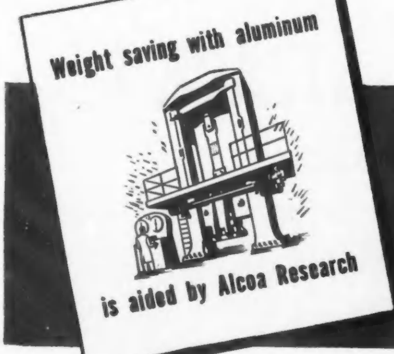
ALUMINUM TIMING GEARS
know what hard work means



Thousands of these aluminum gears are in engines on the road today, put to work there before aluminum was assigned solely to war work. They have given, and continue to give, an excellent account of themselves.

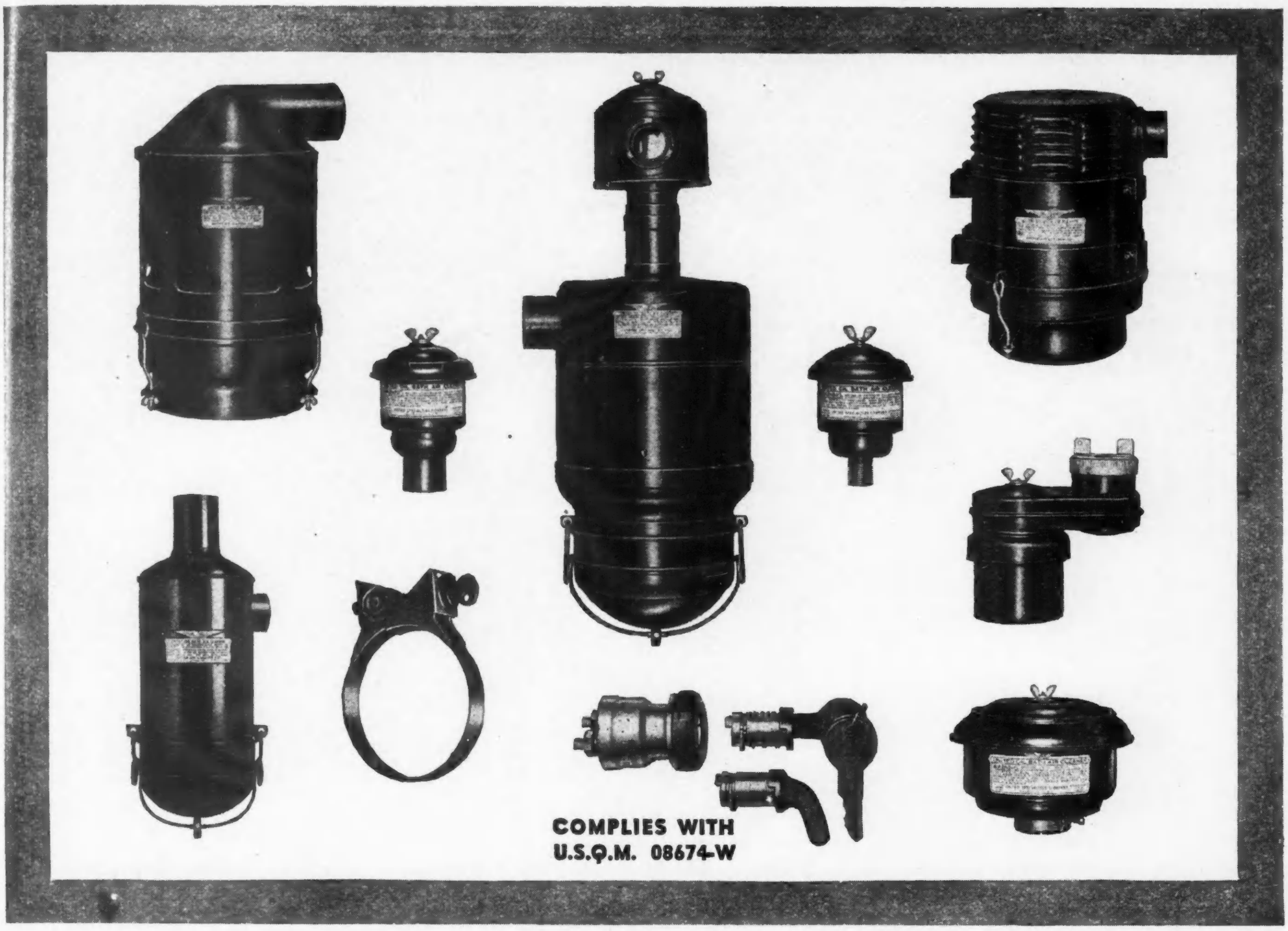
Quiet operation, long life, ease of fabrication and reasonable first cost; these were the factors which led to the adoption of aluminum timing gears. These advantages have been convincingly confirmed during the war years, when the maintenance work on automobile engines has necessarily been held to a minimum.

The blanks are permanent-mold castings made by Alcoa. There is little excess metal to be removed and the Alcoa Aluminum Alloy used cuts readily, so finishing costs are low. The metal is sound, forming clean, long wearing gear teeth. ALUMINUM COMPANY OF AMERICA, 2110 Gulf Building, Pittsburgh, Pennsylvania.



ALCOA
ALUMINUM

What happens when your hat comes down?



ENGINE PROTECTION SPECIALISTS

Technical knowledge and proficiency gained in supplying air cleaners and other engine accessories in great volume for war use, plus 29 years' specialized experience, will produce United products of superior quality for the new engines of tomorrow.

United oil bath air cleaners,
breathers and silencers for gas and diesel engines—260 models to fit every size and type from fractional HP motors to largest tractor, truck and stationary power plants.

United high-pressure hose clamps
withstand pressure of 23 to 70 inch pounds of torque at clamping screws, depending upon diameter of clamps.

Mitchell ignition switches,
dovetails and direction signal switches — pioneers in their fields. *Mitchell Type "41"* ignition switches are widely used on army trucks, transport and other military vehicles, and by various truck manufacturers.

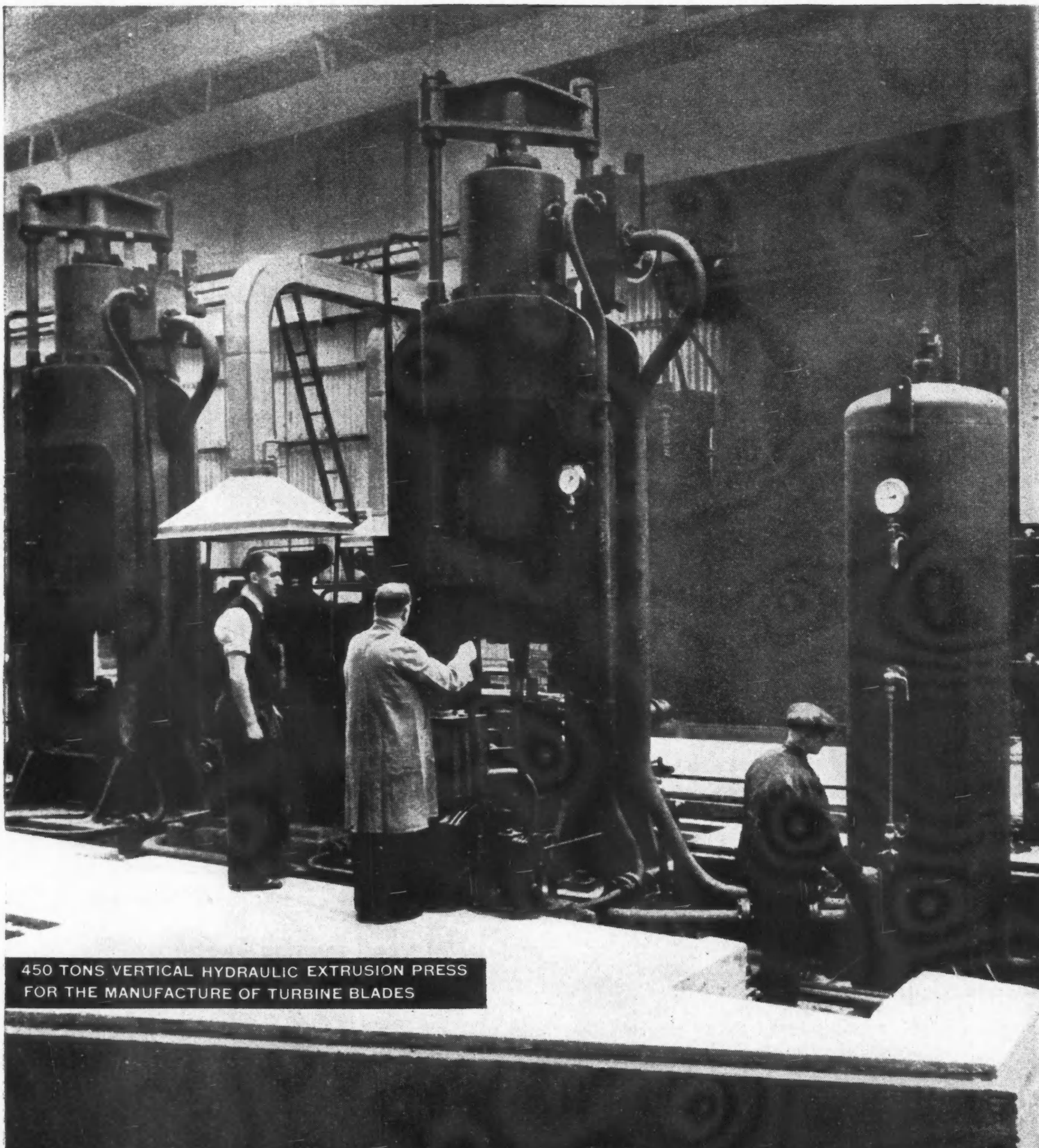
Precision stampings,
(produced in both plants) small to medium size, fabricated into assemblies with tolerances comparable to closely machined parts.

In planning your forthcoming designs you will find our sales engineers helpful in arranging installations to suit your specifications.

UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION
CHICAGO, ILLINOIS

MITCHELL DIVISION
PHILADELPHIA


450 TONS VERTICAL HYDRAULIC EXTRUSION PRESS
FOR THE MANUFACTURE OF TURBINE BLADES

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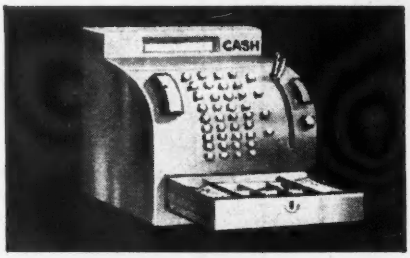
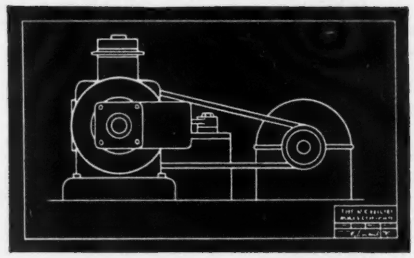
Blueprinting

PROVIDES THE BEST OF ALL TRACING REPRODUCTION METHODS





FASTEST . . .

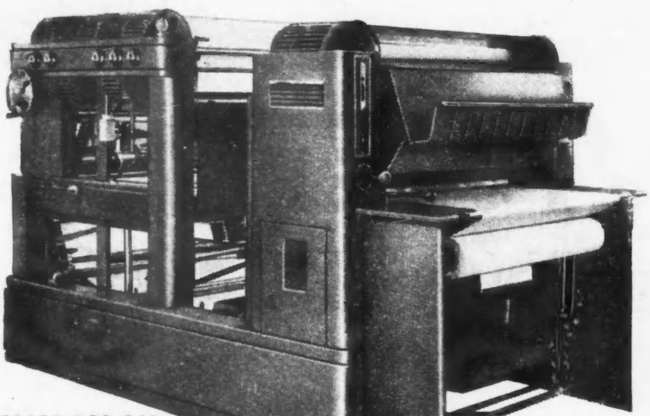
30 feet per minute actual production speed with Pease "22" Continuous Blueprinting and Finishing Machine (not shown) provides quality Blueprints in staggering quantities . . . ON TIME . . . NO WAITING.

LOWEST COST . . .

As low as a cent (and even less) per square foot of finished Blueprints with Pease Continuous Blueprinting and Finishing Machines . . . much higher with other tracing reproduction methods.

FINEST . . .

Blueprints—sharp white lines on deep blue backgrounds, virtually impervious to dirty finger marks. Blueline prints—sharp blue lines on clear white . . . Both easy to handle, lie flat, conserve filing space. Good Blueprints can be made from old, soiled, worn or torn tracings . . . impossible with other tracing reproduction methods.



PEASE "22-16" Continuous Blueprinting and Finishing Machine—Production Speed, 20 feet per minute. (Model "22," not shown, has a Production Speed of 30 feet per minute.)

EXCLUSIVE PEASE FEATURES . . .

- **Sliding "Vacuum-like" Contact** smooths out tracings, prevents errors in printing.
- **Three Speed Lamp Control** provides operation at 10, 15, or 20 amperes, minimizes running speed and dryer heat changes.
- **Actinic "No-Break" Arc Lamps** burn for 45 minutes without breaking arc, resume instantaneously.
- **Horizontal "Floating" Water Wash** floats prints free from tension and prevents wrinkles, stains, bleeding.
- **Quick Change Chemical Applicator System** very economically allows change from Blueprints to Negatives in 20 seconds.
- **Eight-inch Diameter Drying Drums,** thermostatically controlled, heated by gas or electricity, dry the prints "flat as hung wall-paper."

VERSATILITY . . .

Pease Continuous Blueprinting and Finishing Machines are not limited to making Blueprints alone. They also produce excellent Blueline prints, Brownprints and Brownline prints . . . together with a Wet Direct Process Developing Attachment they provide a splendid method of making Black and White prints continuously. . . Moreover, when used in conjunction with a dry direct process developing machine they afford a first rate system for making Whiteprints (dry direct process prints).

Ask for a Pease Tracing Reproduction Specialist to help you with your problems. No obligation of course.

THE C. F. PEASE COMPANY

2635 WEST IRVING PARK ROAD • CHICAGO 18

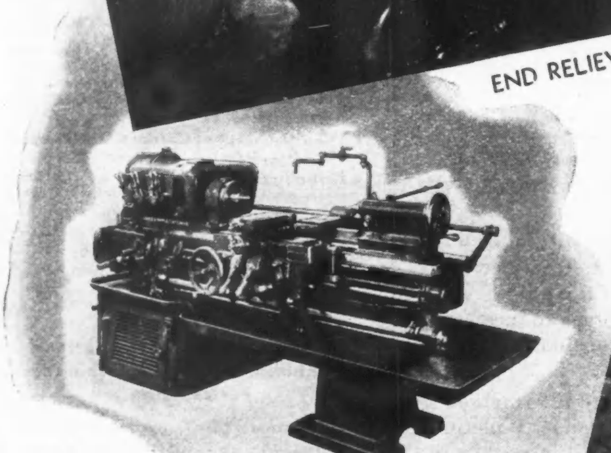
Pease Blueprinting Machines A TYPE AND SIZE FOR EVERY REQUIREMENT INCLUDING DIRECT PROCESS PRINTING AND DEVELOPING MACHINES

Double Duty in YOUR TOOL ROOM

. . . with the Lodge & Shipley Tool Room Lathe, equipped with Universal Relieving Attachment . . .

All the usual jobs, PLUS the ability to do—end, internal, external, plain, angular, or spiral relieving work. Investigate these advantages.

END RELIEVING



PLAIN RELIEVING

GOOD LATHES ONLY
LATHES
SINCE 1892

ARMY E NAVY

Original Navy "E"
Awarded March 6, 1942

THE LODGE & SHIPLEY MACHINE TOOL CO.

CINCINNATI, OHIO, U.S.A.

ENGINE | TOOL ROOM | AUTOMATIC | OIL COUNTRY LATHES

PEDRICK PRECISION plays a part!

WHEN PLASMA SAVES A FIGHTER'S LIFE

● HUMAN SALVAGE has been higher in World War II than in any previous war, due principally to the use of human blood-plasma, which counteracts shock due to loss of blood, and gives the heart "something to beat on."

Pedrick *precisioneered* rings are used in the laboratory processing of blood. Vapors are driven off by a vacuum pump, operated by a compressor with Pedrick rings. Temperatures are held to 50 or 60 degrees below zero. Another compressor, Pedrick-equipped, keeps an alcohol bath at low temperatures . . . likewise a part of blood-processing.

In war and peace, Pedrick *precisioneering* assures correct tension and dimension of rings, with that all-important flatness engineers demand. It's Pedrick's exclusive Heat-Shaping process which makes *precisioneering* possible.

WILKENING MANUFACTURING CO., Philadelphia and Scranton, Pa. *In Canada:* Wilkening Manufacturing Co. (Canada), Ltd., Toronto.

TOMORROW'S DESIGNS START WITH TODAY

Never before was it so necessary to save oil and squeeze the last ounce of power out of every drop of fuel. Pedrick *precisioneered* piston rings can help you do this on the products you are now building or operating. And you can count on their flatness, quick seating, and lasting tension to give superior performance and longer life to the products you will build in the future. Write for our latest catalog showing recommended installations for today and design information for tomorrow.

WILL YOU GIVE ANOTHER PINT OF BLOOD TO SAVE A FIGHTER'S LIFE?

Pedrick *precisioneered* **PISTON RINGS**

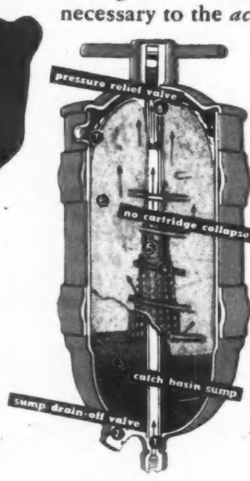
ESSENTIAL TO OIL CLEANSING IS THE DELUXE *Backbone*

In every DeLuxe Cartridge is a backbone . . . a carefully engineered spring that keeps the cartridge from compressing as oil is fed through it. Thus, the density of the DeLuxe cartridge is always maintained to permit the flow of oil through the cartridge at the prescribed rate necessary to the *actual cleansing of the oil.*

Not any kind of a spring will do! DeLuxe research has found that compliance to certain standards for tension, and other qualities, is essential. Rejected for use in DeLuxe cartridges are springs which fail to meet DeLuxe's rigid tests for these qualities.

Only the DeLuxe cartridge has this collapse-preventing backbone. It is one of the exclusive DeLuxe cartridge features which makes the use of the DeLuxe cartridge essential to the proper functioning of the DeLuxe Oil Filter.

Check into all eight of the DeLuxe oil cleansing principles . . . write for your free copy of FILTER FACTS today. When you know all the facts about DeLuxe, you'll know there is no other filter like DeLuxe! Send a post card today. to DeLuxe Products Corp., 1414 Lake St., La Porte, Indiana. In Canada, 364 Richmond St., Toronto.



Genuine DELUXE CARTRIDGES are AVAILABLE.

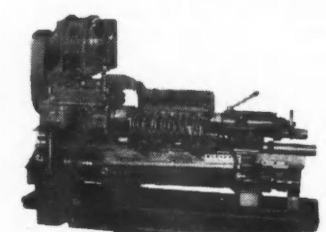
Accept No Substitute.

DELUXE *Oil Filter*

DOES MORE THAN STRAIN OIL . . . MORE THAN FILTER OIL

ACTUALLY CLEANSES OIL

did you ever see a DREAM flying?



Jones & Lamson Fay Automatic Lathe for machining landing gear strut cylinders

In great grandfather's day some unknown illustrator of dime novels . . . some minor Jules Verne . . . dreamed and made a picture of this contraption. Although striking in its resemblance to our present day helicopter, it flew only in his imagination.

But imagination was not enough. Before dreamers could join the birds their ideas had to be put into production.

Men are still dreaming of flight . . . of flying faster, farther, higher . . . of carrying greater loads and carrying them cheaper . . . of putting more aircraft into the service of more people. And working with them, helping to ready their ideas for practical, economical production, are the makers of Jones & Lamson machine tools.

They are at your service too, as they have been for more than a century, to help you turn today's plans into tomorrow's realities.

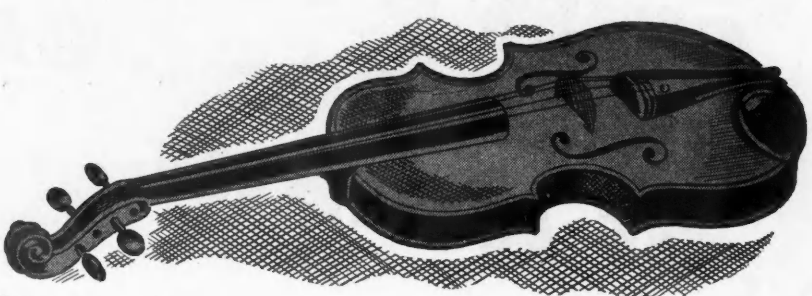
Jones & Lamson Fay Automatic Lathes are used throughout the aircraft industry —from the machining of the engines that deliver the power-punch to victorious American war planes—to the landing gear that cushions their return to earth. As time goes on, even mightier craft will fly our airways and we, at Jones & Lamson, will be ready with the tools and service to be used in their production.

JONES & LAMSON
MACHINE COMPANY
Springfield, Vermont, U.S.A.

J&L

Manufacturers of: Universal Turret Lathes • Fay Automatic Lathes • Automatic Double-End Milling and Centering Machines • Automatic Thread Grinders • Optical Comparators • Automatic Opening Threading Dies and Chasers.

Profit-producing Machine Tools



Proved true by time

Time alone can prove how good capacitors are. The enviable reputation of Tobe Capacitors for *long life* rests on an almost complete absence of "returns". Such things don't "just happen". Back of Tobe Capacitors are constant research, specialized manufacturing experience and rigid inspections. Ratings are always on the conservative side.

Whatever your condenser problems, we invite you to put them up to our engineers. You will receive prompt service and close co-operation.

LONG LIFE ASSURED

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

TRS 605,
5 mfd. 600 volts

SIZE—
Overall height 5"

CONTAINER—
1 3/16" x 2 1/2" x 4"

Dimensions of other TRS models on request.

SPECIFICATIONS FOR TRS CAPACITORS

CAPACITY—.1 to 50.0 mfd.

WORKING VOLTAGE—
600 volts DC to 6,000 volts DC.

SHUNT RESISTANCE—
15,000 megohms per mfd.

RESISTANCE Terminal to Case—
10,000 megohms minimum.

POWER FACTOR—.002 to .005

VOLTAGE TEST Terminal to Case—
2,500 VDC for 600 volt condensers.

Capacitor unit tested at 2½ times rated voltage.

Universal (wrap around) L or foot type and screw Spade-lug mounting brackets can be supplied.

A small part in Victory today . . . **A BIG PART IN INDUSTRY TOMORROW**

IN THIS ISSUE . . . .

AUTOMOTIVE and AVIATION INDUSTRIES

Volume 90 March 15, 1944 Number 6

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

WAR PRODUCTION

MAN POWER

GENERAL INDUSTRIAL

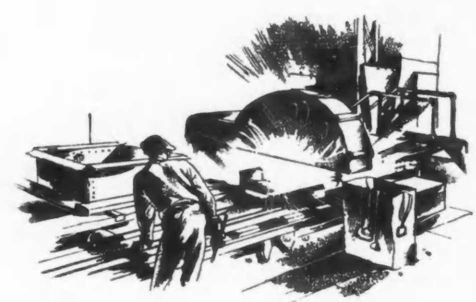
AUTOMOTIVE

AVIATION

MATERIALS

SPECIFICATIONS

Can These Ryerson Skills Help You?



Steel Cut to Close Tolerance. Experienced crews working with modern high-speed friction saws, giant shears, powerful hack saws and other metal-working machinery can turn out steel quickly—cut, formed or otherwise prepared to your requirements. Steel that is cut to exact size and specification eliminates scrap and frees your man-hours for more production.

Any Shape Expertly Flame Cut. Skilled operators and modern equipment—combined with ever-present stocks of all types of steel—assure quick, accurate flame cutting and prompt delivery. Almost any shape, no matter how intricate, can be fashioned from steel plates or shapes. You save the time and expense of forging or casting and gain the added strength of rolled steel. Complete welded and riveted assemblies are also fabricated by Ryerson.

Metallurgical Help For Steel Problems. Our staff of engineers and metallurgists are experienced in serving customers in every branch of industry. These men have displayed a genius for solving problems pertaining to steel application, heat treating and fabrication. Theirs is the practical type of *know-how* and you can depend on them to work with you whenever a difficulty arises.

Speedy Delivery Without An Expediter. Every man and woman in our eleven strategically-located plants knows the meaning of the word *rush!* The Ryerson organization is geared to getting your steel delivered in the shortest possible time. Write for your copy of the Ryerson Stock List—complete catalog of steels in stock for immediate shipment including: bars, shapes, plates, sheets, structurals, tubing, carbon and alloy steel, tool steel, Allegheny Stainless and many others.

JOSEPH T. RYERSON & SON, INC., STEEL-SERVICE PLANTS AT: CHICAGO, MILWAUKEE, ST. LOUIS, CINCINNATI, DETROIT, CLEVELAND, PITTSBURGH, PHILADELPHIA, BUFFALO, BOSTON, JERSEY CITY.

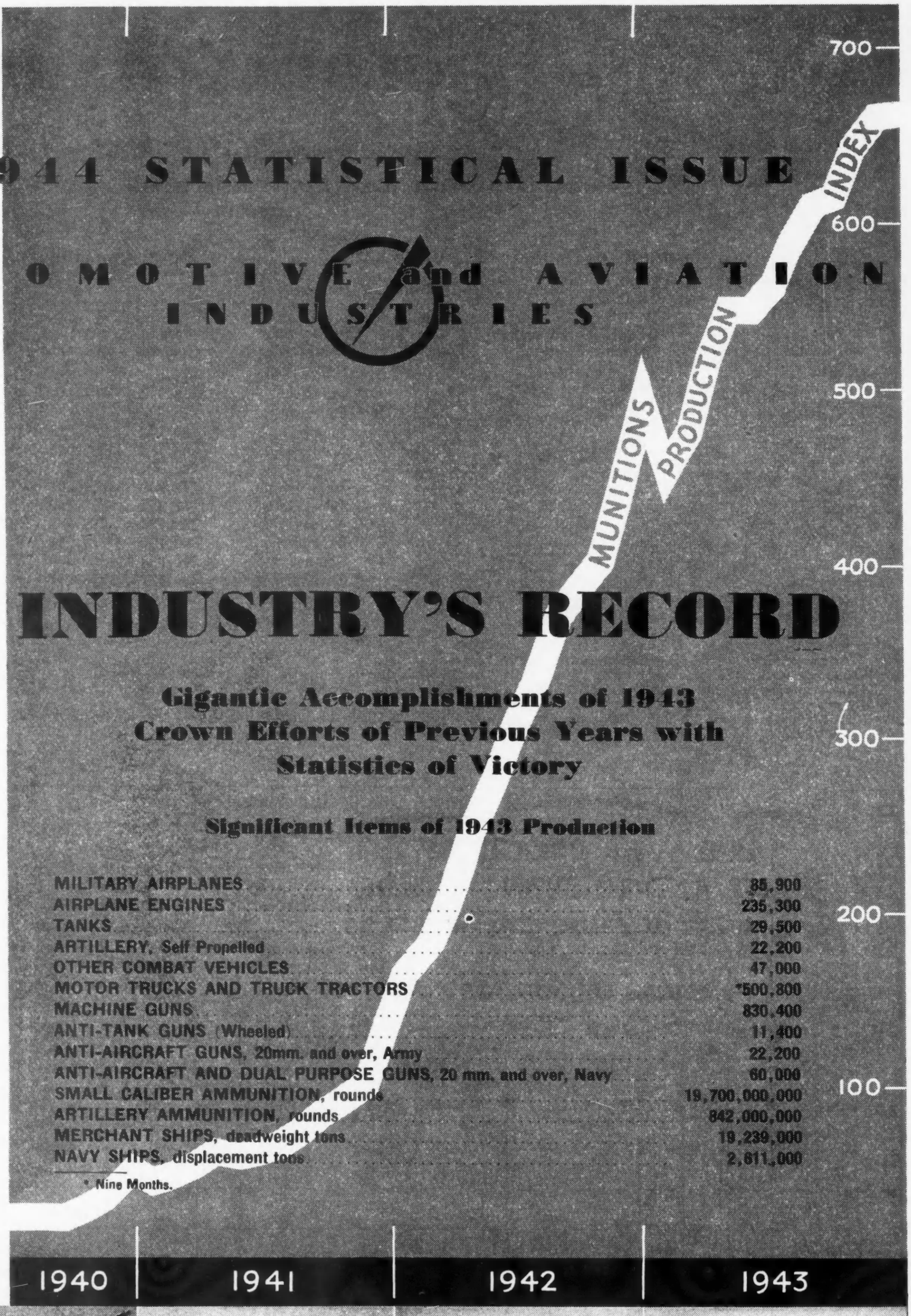
RYERSON

1944 STATISTICAL ISSUE

AUTOMOTIVE and AVIATION INDUSTRIES

INDUSTRY'S RECORD

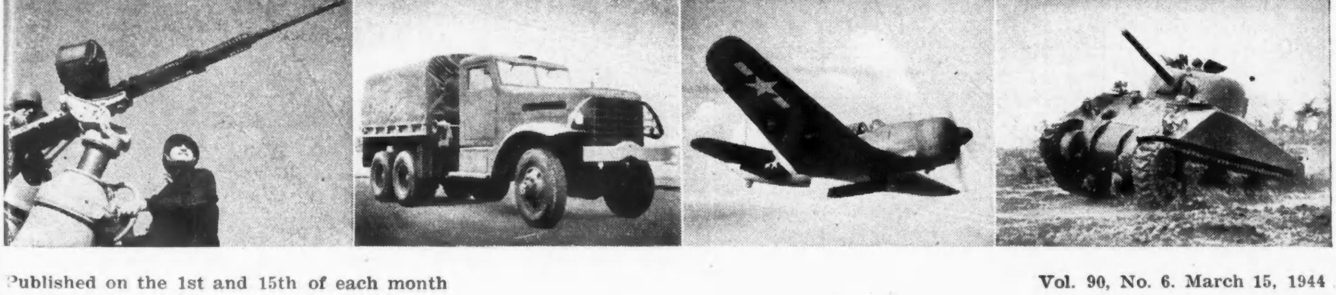
Gigantic Accomplishments of 1943 Crown Efforts of Previous Years with Statistics of Victory



Significant Items of 1943 Production

MILITARY AIRPLANES	85,900
AIRPLANE ENGINES	235,300
TANKS	29,500
ARTILLERY, Self Propelled	22,200
OTHER COMBAT VEHICLES	47,000
MOTOR TRUCKS AND TRUCK TRACTORS	*500,800
MACHINE GUNS	830,400
ANTI-TANK GUNS (Wheeled)	11,400
ANTI-AIRCRAFT GUNS, 20mm. and over, Army	22,200
ANTI-AIRCRAFT AND DUAL PURPOSE GUNS, 20 mm. and over, Navy	60,000
SMALL CALIBER AMMUNITION, rounds	19,700,000,000
ARTILLERY AMMUNITION, rounds	842,000,000
MERCHANT SHIPS, deadweight tons	19,239,000
NAVY SHIPS, displacement tons	2,611,000

* Nine Months.



Published on the 1st and 15th of each month

Vol. 90, No. 6. March 15, 1944

U. S. War Program Commitments and Expenditures

Cumulative Totals from June 30, 1940, to End of Month Specified

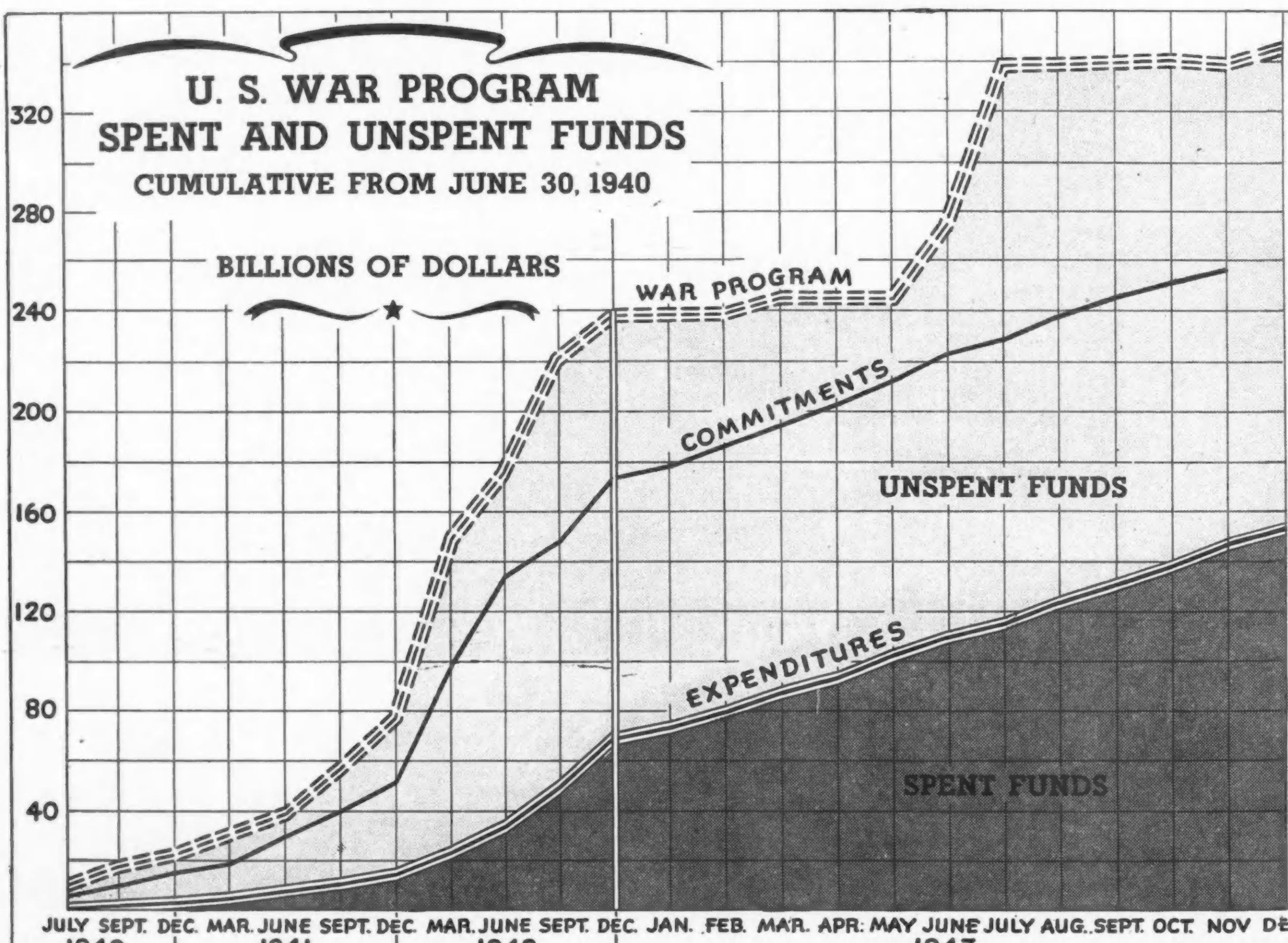
(Millions of Dollars)

Year and Month	War Program	Commitments	Expenditures	Indicated Unspent Funds
1940				
July	$9,401	$4,005	$199	$9,202
September	19,301	10,560	673	18,628
December	21,355	14,537	1,911	19,444
1941				
March	31,240	19,181	3,963	27,277
June	38,084	29,212	6,655	31,429
September	57,865	40,340	10,412	47,453
December	77,710	48,145	15,803	61,907
1942				
March	146,744	99,497	23,422	123,322
June	175,599	119,682	34,921	140,678
September	221,918	148,627	50,250	171,668
December	237,949	173,184	68,208	169,741
1943				
January	$238,398	$179,174	$74,461	$163,937
February	238,952	185,776	80,543	158,409
March	246,147	193,323	87,655	158,492
April	246,116	202,443	94,945	151,171
May	246,024	212,323	102,318	143,746
June	275,753	222,207	110,005	165,748
July	339,854	230,252	116,751	223,103
August	339,738	238,375	124,280	215,458
September	340,167	244,734	131,492	208,675
October	340,033	250,466	138,597	201,436
November	338,971	256,611	146,391	192,580
December	344,141	....	153,342	190,799

War program includes all funds made available for war purposes by the U. S. Government, including cash appropriations, contract and tonnage authorizations, and commitments by the Reconstruction Finance Corporation and its subsidiaries.

Commitments include contract awards, letters of intent, letter contracts, orders to Government Arsenals, and other actions which legally commit funds.

Expenditures include checks paid from the Treasury General Fund and net expenditures by the Reconstruction Finance Corp. and its subsidiaries.



FINANCIAL DATA ★ ★ ★

War Appropriations by Agency*

Cumulative from June, 1940, to end of month indicated

(Billions of Dollars)

	War Department	Navy Department	Lend-Lease	RFC and Subsidiaries	Other U. S. War Agencies	Total
June 30, 1941	$13.2	$12.3	$7.0	$2.6	$2.0	$37.1
December 31, 1942	$126.7	$64.4	$18.4	$15.2	$13.2	$237.9
1943						
January	$126.7	$64.4	$18.4	$15.8	$13.1	$238.4
February	126.7	64.4	18.4	15.9	13.6	239.0
March	126.7	66.2	18.4	16.0	18.8	246.1
April	126.7	66.1	18.4	16.0	18.9	246.1
May	126.7	66.0	18.4	15.9	19.0	246.0
June	126.7	88.8	24.7	16.6	19.0	275.8
July	185.7	90.5	24.7	16.5	22.5	339.8
August	185.7	90.5	24.7	16.3	22.5	339.7
September	185.7	90.5	24.7	16.6	22.7	340.2
October	185.7	90.5	24.7	16.4	22.7	340.0
November	185.7	89.5	24.7	16.7	22.4	339.0
December	185.7	94.4	24.7	16.8	22.5	345.1

*—War Production Board.

War Commitments by Agency*†

Cumulative from June, 1940, to end of month indicated

(Billions of Dollars)

	War Department	Navy Department	Lend-Lease	RFC and Subsidiaries	Other U. S. War Agencies	Total
June 30, 1941	$11.1	$11.2	$2.5	$2.6	$1.6	$29.0
December 31, 1942	$85.8	$47.0	$12.9	$15.2	$12.3	$173.2
1943						
January	$89.0	$48.5	$13.2	$15.8	$12.7	$179.2
February	92.5	50.7	13.6	15.9	13.1	185.8
March	95.8	54.1	14.0	16.0	13.4	193.3
April	99.4	56.3	14.2	16.0	16.5	202.4
May	105.4	59.0	14.6	15.9	17.4	212.3
June	111.5	60.9	15.1	16.6	18.2	222.3
July	115.6	63.4	15.3	16.5	19.0	229.8
August	121.2	66.2	15.8	16.3	18.8	238.3
September	124.2	67.8	16.7	16.6	19.4	244.7
October	126.8	70.0	17.2	16.4	20.0	250.4
November	130.1	72.0	17.4	16.7	20.4	256.6
December	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

*—War Production Board. †—Includes obligations or formal contracts only.

War Construction Completed*

(Government Financed)

	Millions of Dollars †
1940	
Third quarter	$171
Fourth quarter	475
Total—6 months	$646
1941	
First quarter	$854
Second quarter	947
Third quarter	1,341
Fourth quarter	1,677
Total—1941	$4,819
Cumulative Total	$5,465
1942	
January	$621
February	641
March	794
April	995
May	1,095
June	1,263
July	1,493
August	1,590
September	1,555
October	1,449
November	1,353
December	1,216
Total—1942	$14,065
Cumulative Total	$19,530
1943	
January	$1,234
February	1,188
March	1,196
April	1,104
May	1,060
June	1,015
July	938
August	885
September	758
October	701
November	P642
December	E586
Total—1943	$11,307
Cumulative Total	$30,837

*—War Production Board.
P—Preliminary. E—Estimated.
†—Includes overseas construction.

Sales of War Savings Bonds*

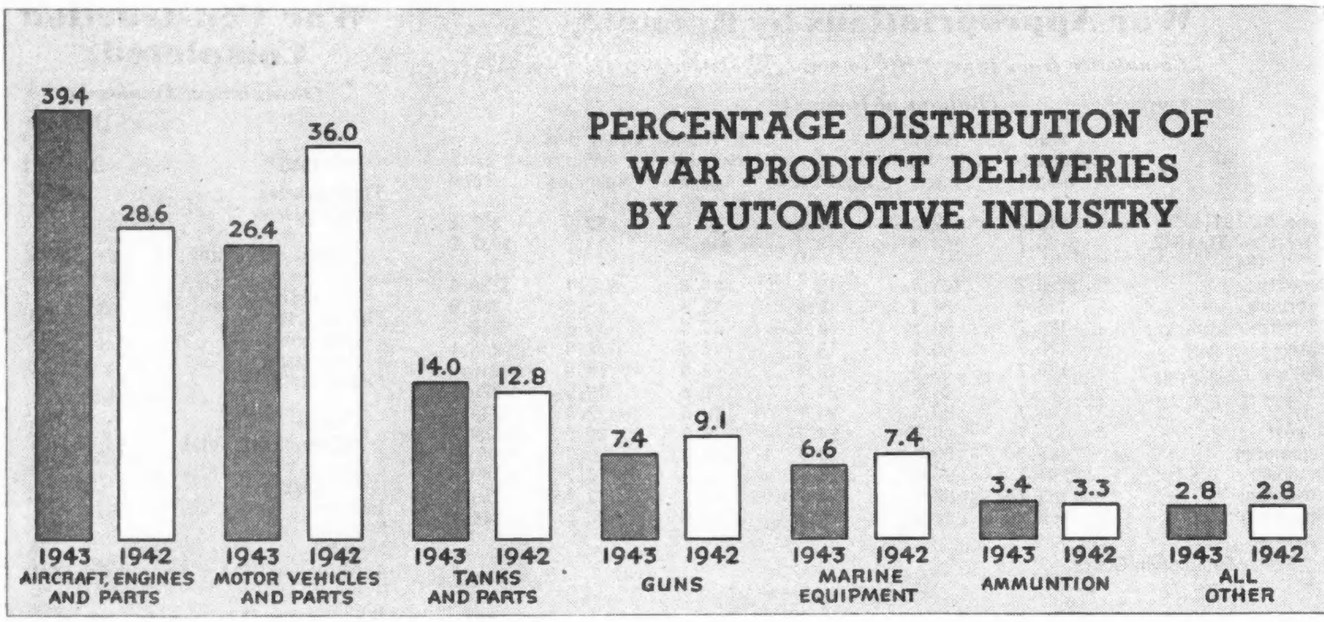
(Millions of Dollars)

1942	Amount Outstanding	Sales, Series E, F, G.	Redemptions	Per Cent Redemptions are of Sales
January	...	$1,061	...	...
February	...	703	...	...
March	...	558	...	...
April	...	531	...	...
May	...	634	...	...
June	...	634	...	...
July	...	901	...	...
August	$11,751	734	$32	4.35
September	12,479	838	34	4.05
October	13,381	814	40	4.91
November	14,079	735	43	5.85
December	15,050	1,014	55	5.42

1943	Amount Outstanding	Sales, Series E, F, G.	Redemptions	Per Cent Redemptions are of Sales
January	$16,246	$1,240	$63	5.08
February	17,068	887	76	8.56
March	17,891	944	131	13.87
April	19,267	1,470	103	7.00
May	20,507	1,335	104	7.79
June	21,256	876	141	16.09
July	22,030	890	138	15.50
August	22,694	802	152	18.95
September	24,478	1,927	155	8.04
October	26,056	1,708	144	8.43
November	26,697	798	171	21.42
December	27,363	853	207	24.30

*—U.S. Treasury Department.

★ AUTOMOTIVE INDUSTRY ★

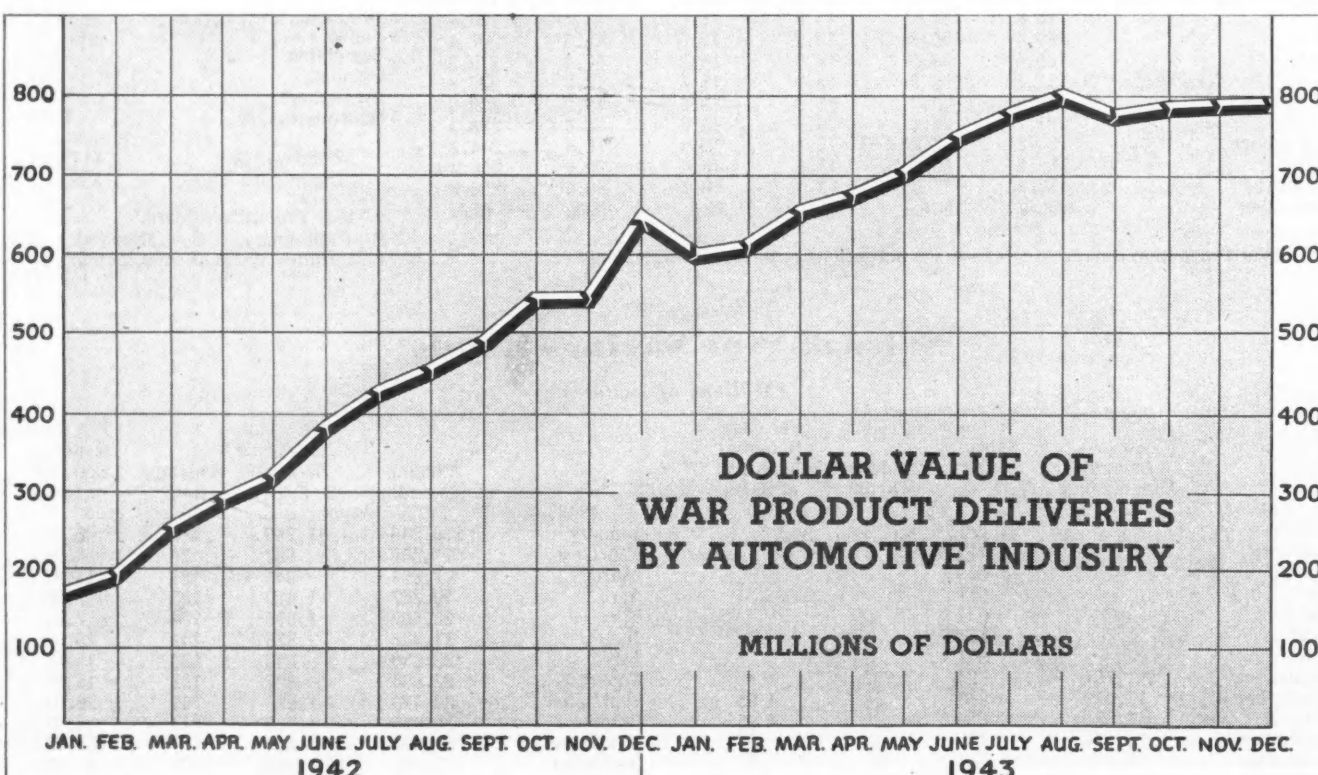


Monthly Value of War Product Deliveries by Automotive Industry

	1942	1943		1942	1943
January	$165,300,000	$595,500,000	August	$452,900,000	$796,600,000*
February	191,400,000	606,300,000	September	485,300,000	777,300,000*
March	254,700,000	650,000,000	October	540,700,000	785,900,000*
April	291,100,000	668,100,000	November	539,600,000	787,200,000*
May	313,200,000	698,700,000	December	645,800,000	788,000,000*
June	383,800,000	743,000,000			
July	427,200,000	779,400,000*	Totals	$4,691,000,000	$8,676,000,000

Source—Automotive Council for War Production.

* Preliminary data.



★ ★ ★ LEND-LEASE AID

Lend-Lease Aid by Type

Per Cent of Total Aid

	1941	1942	Jan.-Nov. 1943
Munitions	21.5	46.7	60.7
Industrial Items	21.9	20.9	21.2
Foodstuffs, etc.	29.8	12.8	10.7
Services	26.8	19.6	7.4
Total	100.0	100.0	100.0

Lend-Lease Aid

March, 1941, Through November 30, 1943

	Dollar Volume	Per Cent of Total
GOODS TRANSFERRED		
Munitions	$9,827,519,000	52.8
Industrial Items	3,931,531,000	21.1
Foodstuffs, etc.	2,376,799,000	12.8
Total Transfers	$16,135,849,000	86.7
SERVICES RENDERED		
Servicing and Repair of Ships, etc.	$400,728,000	2.2
Rental of Ships, Ferrying of Aircraft, etc.	1,382,583,000	7.4
Production Facilities in U. S.	604,604,000	3.2
Miscellaneous Expenses	84,789,000	0.5
Total Services	$2,472,704,000	13.3
TOTAL LEND-LEASE AID	$18,608,553,000	100.0

The above figures are exclusive of the value of goods consigned to the United States commanding generals for subsequent transfer in the field to lend-lease countries. The total value of such consignments to November 30, 1943 was $438,741,000.

Lend-Lease Exports by Type and Destination

March, 1941, Through October 31, 1943

Millions of Dollars

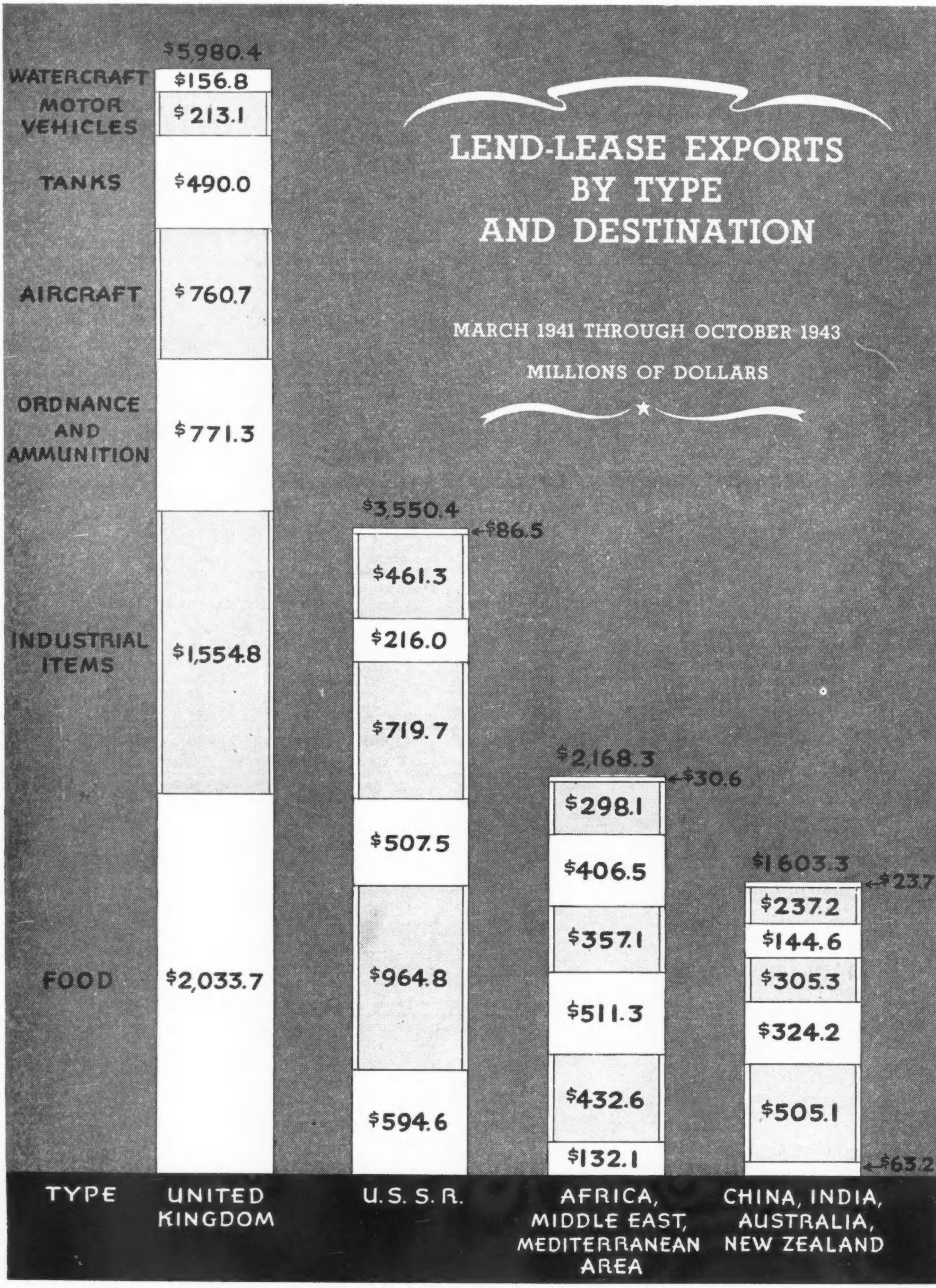
	United Kingdom	U.S.S.R.	Africa, Middle East, Mediterranean Area	China, India, Australia, New Zealand	Other Countries	Total
MUNITIONS						
Ordnance	$256	$171	$219	$138	$55	$839
Ammunition	515	336	293	187	57	1,388
Aircraft and Parts	761	720	357	305	249	2,392
Tanks and Parts	490	216	407	145	33	1,291
Motor Vehicles and Parts	213	461	298	236	46	1,254
Watercraft	156	87	30	24	19	316
Total	$2,391	$1,991	$1,604	$1,035	$459	$7,480
INDUSTRIAL ITEMS						
Machinery	345	354	98	133	22	952
Metals	502	376	123	164	18	1,183
Petroleum Products	423	27	61	97	....	608
Other	285	208	150	111	29	783
Total	$1,555	$965	$432	$505	$69	$3,526
AGRICULTURAL PRODUCTS						
Foods	1,592	532	126	36	12	2,298
Other Agricultural Products	442	62	6	27	3	540
Total	$2,034	$594	$132	$63	$15	$2,838
TOTAL LEND-LEASE EXPORTS	$5,980	$3,550	$2,168	$1,603	$543	$13,844

The above figures do not include (1) articles transferred to foreign countries but used in the United States; (2) some ships which leave the United States under their own power; (3) some goods consigned to U. S. commanding generals for subsequent transfer to lend-lease countries; (4) materials which have been transferred but not yet exported; (5) goods purchased outside the U. S. and sent directly to lend-lease countries; (6) some other items of relatively small amount.

Countries Eligible for Lend-Lease Aid

Argentina
Australia *
Belgium *
Bolivia *
Brazil *
Canada
Chile *
China *
Colombia *
Costa Rica *
Cuba *
Czechoslovakia *
Dominican Rep. *
Ecuador *
Egypt
El Salvador *
Ethiopia *
Fighting France
French North and West Africa
Greece *
Guatemala *
Haiti *
Honduras *
Iceland *
India
Iran
Iraq
Liberia *
Luxembourg
Mexico *
Netherlands *
New Zealand *
Nicaragua *
Norway *
Panama
Paraguay *
Peru *
Philippines
Poland *
Saudi Arabia
South Africa
Turkey
United Kingdom *
U.S.S.R. *
Uruguay *
Venezuela *
Yugoslavia *

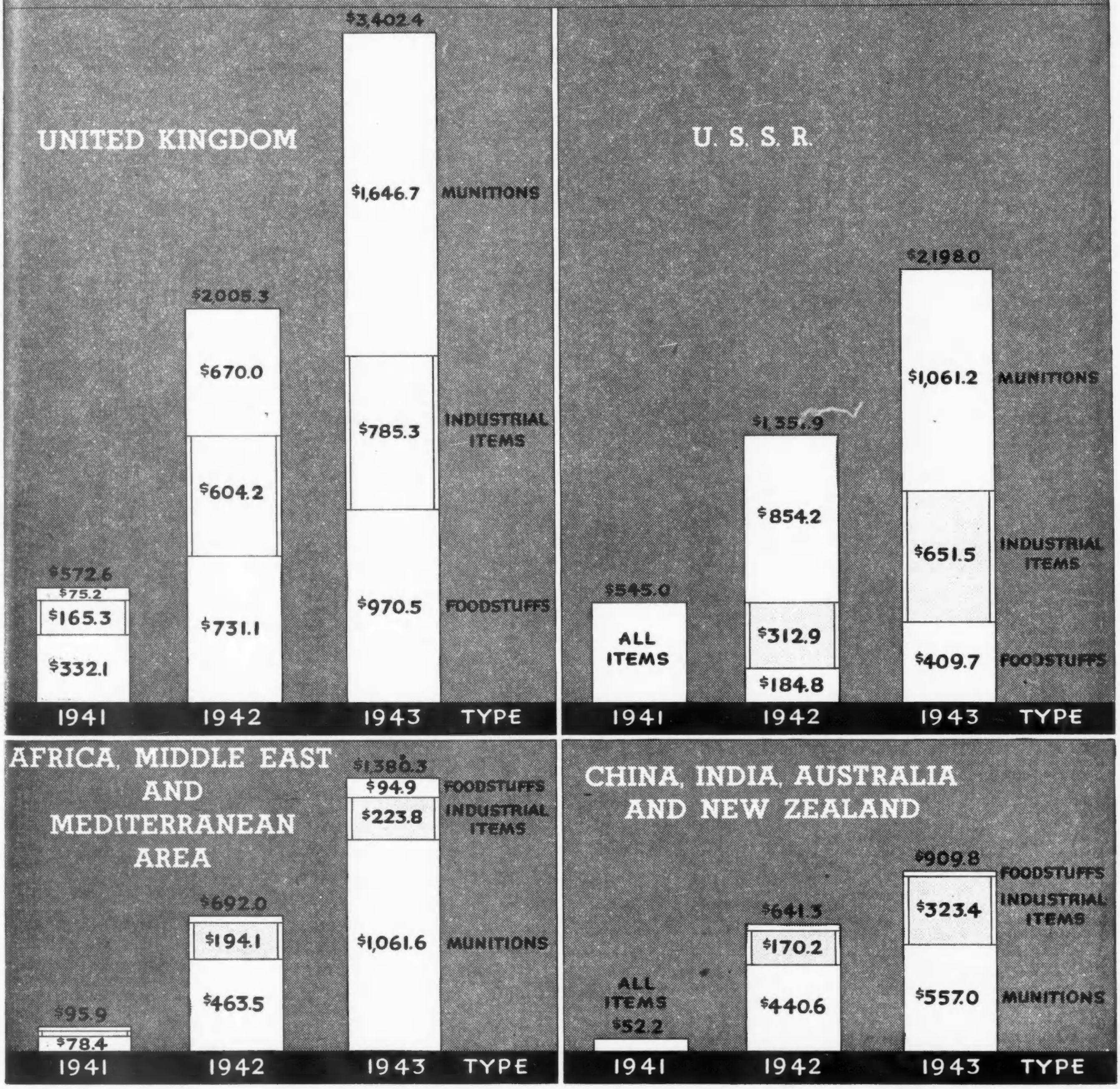
*—Those countries which have signed Lend-Lease Agreement.


LEND-LEASE EXPORTS BY TYPE AND DESTINATION
MARCH 1941 THROUGH OCTOBER 1943
MILLIONS OF DOLLARS
TYPE
WATERCRAFT
MOTOR VEHICLES
TANKS
AIRCRAFT
ORDNANCE AND AMMUNITION
INDUSTRIAL ITEMS
FOOD
UNITED KINGDOM
$5,980.4
$156.8
$213.1
$490.0
$760.7
$771.3
$1,554.8
$2,033.7
U. S. S. R.
$3,550.4
$86.5
$461.3
$216.0
$719.7
$507.5
$964.8
$594.6
AFRICA, MIDDLE EAST, MEDITERRANEAN AREA
$2,168.3
$30.6
$298.1
$406.5
$357.1
$511.3
$432.6
$132.1
CHINA, INDIA, AUSTRALIA, NEW ZEALAND
$1 603.3
$23.7
$237.2
$144.6
$305.3
$324.2
$505.1
$63.2

LEND-LEASE EXPORTS OF AUTOMOTIVE AND AVIATION PRODUCTS

	United Kingdom	U. S. S. R.	Middle East	Far East	Total
AIRCRAFT AND PARTS					
1941	$13,330,000	$	$ 2,022,000	$ 7,995,000	$ 23,347,000
1942	275,752,000	303,396,000	114,590,000	97,139,000	790,877,000
1943	471,608,000	416,282,000	240,491,000	200,173,000	1,328,554,000
TANKS AND PARTS					
1941	$ 10,521,000	$ 35,000	$ 30,572,000	$ 1,935,000	$ 43,063,000
1942	35,998,000	176,804,000	49,397,000	100,380,000	362,579,000
1943	443,438,000	39,114,000	326,533,000	42,331,000	851,461,000
MOTOR VEHICLES AND PARTS					
1941	$14,559,000	$	$10,758,000	$17,856,000	$ 43,173,000
1942	61,950,000	149,092,000	115,066,000	75,145,000	401,253,000
1943	136,556,000	312,184,000	172,281,000	144,152,000	785,153,000

LEND-LEASE EXPORTS — MILLIONS OF DOLLARS



Distribution of Major War Supply and Facility Contracts and Allocations by Agency[1]

**Arranged by States According to Dollar Volume of Contracts Awarded.
Cumulative, June, 1940, through November, 1943.**

(Thousands of Dollars)

STATE	All Agencies Reporting	Army, Navy, Maritime Commission, Treasury and Foreign Purchasing Missions (2)	Department of Commerce		Federal Works Agency		Federal Security Agency	War Manpower Commission	National Housing Agency
			C. A. A. (3)	R. F. C. (4)	War Public Works (5)	W. P. A. (6)	Office of Education (7)	N. Y. A. (8)	F. P. H. A. (9)
Michigan	$18,801,069	$18,627,511	$ 480	$ 31,493	$ 17,806	$ 10,964	$ 13,803	$ 5,869	$ 93,143
New York	16,145,111	15,945,804	3,334	26,909	6,809	32,276	39,776	12,563	77,640
California	15,843,090	15,399,544	2,233	36,948	31,765	39,186	31,262	4,354	297,798
Ohio	12,187,122	11,940,240	4,830	90,683	7,804	15,990	15,333	7,069	105,173
Pennsylvania	10,688,096	10,462,010	1,383	18,514	4,029	19,510	35,906	12,241	134,503
New Jersey	10,512,179	10,397,711	3,890	41,904	2,332	15,029	9,212	3,347	38,754
Illinois	9,788,272	9,669,070	3,016	9,607	4,920	24,144	17,278	10,351	49,886
Indiana	7,066,974	6,991,805	2,461	5,494	4,702	9,428	9,294	3,815	39,975
Connecticut	5,881,324	5,801,055	693	2,654	5,451	4,733	4,239	1,464	61,035
Massachusetts	5,324,720	5,248,641	1,478	4,150	2,428	27,951	11,115	3,885	25,072
Texas	5,171,911	4,986,858	10,863	8,264	24,811	22,833	15,638	8,024	94,620
Washington	4,849,117	4,621,753	6,874	10,907	16,095	14,118	7,949	1,620	169,801
Maryland	4,342,969	4,214,195	1,930	17,751	8,363	9,214	4,290	1,650	85,586
Wisconsin	3,570,508	3,537,951	1,747	1,240	1,020	7,258	7,966	4,429	8,897
Kansas	2,989,132	2,928,527	693	8,871	3,637	4,327	4,554	2,491	36,032
Missouri	2,932,766	2,881,034	3,267	6,765	5,227	11,884	6,081	3,714	14,794
Virginia	2,180,536	1,968,053	1,511	2,462	34,589	6,815	5,333	2,844	158,929
Tennessee	1,849,791	1,816,540	120	1,904	4,304	5,466	6,614	2,450	12,393
Oklahoma	1,741,057	1,707,997	3,767	717	2,893	7,102	5,493	4,715	8,383
Minnesota	1,557,595	1,536,022	1,616	1,034	184	10,041	5,596	3,044	58
Alabama	1,541,583	1,447,112	2,214	8,307	10,216	11,925	8,918	3,151	49,740
Oregon	1,501,394	1,376,318	6,223	27,072	1,451	9,758	8,789	976	70,807
Georgia	1,487,933	1,407,792	5,198	4,516	7,009	8,259	6,388	4,510	44,261
Louisiana	1,459,678	1,417,933	2,199	3,233	5,194	10,851	5,865	2,664	11,739
North Carolina	1,296,059	1,230,390	4,674	730	10,170	9,516	5,517	3,985	31,077
Florida	1,249,785	1,145,967	12,935	6,781	6,245	29,107	7,231	2,462	39,057
Maine	1,185,758	1,147,487	2,227	1,105	3,629	9,914	1,970	2,179	17,247
Kentucky	1,009,838	931,380	3,439	40,823	3,032	9,839	5,564	3,882	11,879
Nebraska	964,564	946,604	495	588	641	3,961	1,677	1,351	9,247
Rhode Island	890,985	866,309	329	13	5,580	2,462	1,139	497	14,656
Iowa	889,467	869,667	3,949	1,186	1,033	3,567	3,024	2,690	4,351
West Virginia	667,630	642,925	2,090	392	781	4,782	5,793	4,256	6,611
Mississippi	618,586	578,727	426	480	4,325	7,290	5,570	2,887	18,881
Utah	608,548	563,860	337	674	3,628	3,487	3,980	733	31,849
Colorado	579,397	558,044	236	1,811	802	7,165	4,116	1,057	6,166
South Carolina	566,048	504,516	4,311	294	5,662	21,036	3,131	1,913	25,185
Arkansas	426,638	397,126	1,732	670	1,882	2,818	2,706	2,899	16,805
Arizona	308,960	275,260	1,754	1,676	1,749	4,772	1,535	490	21,724
New Hampshire	281,523	267,232	108	95	770	3,531	1,929	485	7,373
Delaware	262,132	249,711	1,170	.....	220	1,545	1,409	175	7,902
Nevada	241,951	223,269	506	201	2,181	296	176	36	15,286
District of Columbia	165,097	98,194	150	157	7,895	8,988	1,546	507	47,660
Idaho	134,909	122,338	1,098	419	211	2,281	1,503	968	6,091
Vermont	125,506	120,045	636	214	171	1,265	873	427	1,875
New Mexico	117,464	102,119	2,585	279	262	3,484	1,471	547	6,717
South Dakota	73,104	65,836	290	.....	426	1,135	709	836	3,872
Montana	72,306	63,106	1,188	267	15	3,117	778	440	3,398
Wyoming	61,162	53,859	1,279	261	255	691	1,217	238	3,362
North Dakota	10,093	4,147	2,870	136	160	1,260	784	736	.....
Off Continent and Unassigned	18,333,625	17,584,163	17,029	640,887	20,280	28,691	1,873	301	40,411
Total Reported	$180,555,062	$175,943,757	$139,863	$1,071,528	$295,044	$515,062	$353,893	$148,217	$2,087,698

(1)—War Production Board.

(2)—Prime supply contracts and facilities projects. Defense Plant Corp. commitments for industrial facilities are included.

(3)—Allotments for airport construction to the C.A.A. and W.P.A. from the Development of Landing Areas Program appropriation. Allotments from this D.L.A. appropriation to Army and Navy are included with other Army and Navy contracts.

(4)—Reconstruction Finance Corporation. War loan commitments for working capital and non-industrial facilities through October 1943.

(5)—Federal Works Agency, War Public Works. Allotments for construction through October 1943.

(6)—Federal Works Agency, Work Projects Administration. Expenditures on certified war projects July 1940 through April 1943.

(7)—War training expenditures.

(8)—National Youth Administration. Allotments for war training for fiscal year 1941 and encumbrances from July 1941 through June 1943.

(9)—Federal Public Housing Administration. Awards for war housing.

Distribution of Major War Supply Contracts and Facility Projects by State and Type[1]

Arranged by States According to Dollar Volume of Contracts Awarded. Cumulative from July, 1940.

(Thousands of Dollars)

STATE	Total Army, Navy, Maritime Com., Treasury and Foreign Purchasing Com.	SUPPLY CONTRACTS—THROUGH NOVEMBER 1943					FACILITY PROJECTS—THROUGH OCTOBER 1943		
		Total	Aircraft	Ships	Ordnance	All Other	Total	Industrial	Non-Industrial
Michigan	$18,627,511	$17,483,120	$5,617,845	$772,717	$6,842,304	$4,250,254	$1,144,391	$1,068,973	$75,418
New York	15,945,804	14,537,042	5,118,071	852,801	3,754,715	4,811,455	1,408,762	1,003,892	404,870
California	15,399,544	13,562,654	8,715,868	3,655,838	311,355	879,593	1,836,890	837,880	999,010
Ohio	11,940,240	10,656,376	3,012,615	1,254,114	2,641,041	3,748,606	1,283,864	1,135,179	148,695
Pennsylvania	10,462,010	9,060,272	784,372	1,563,154	3,253,270	3,459,476	1,401,738	1,165,629	236,109
New Jersey	10,397,711	9,685,272	3,304,509	2,193,395	1,053,669	3,133,699	712,439	493,878	228,561
Illinois	9,669,070	8,465,624	1,473,241	251,203	3,097,377	3,643,803	1,203,446	1,003,342	200,104
Indiana	6,991,805	6,032,951	2,355,134	345,226	1,942,935	1,339,656	958,854	794,190	164,684
Connecticut	5,801,055	5,555,151	2,631,851	290,652	1,829,880	802,768	245,904	222,743	23,161
Massachusetts	5,248,641	4,766,038	269,814	1,583,009	858,891	2,054,324	482,603	302,630	179,973
Texas	4,986,858	3,272,027	1,368,694	1,116,973	236,491	549,869	1,714,831	889,675	825,156
Washington	4,621,753	4,063,374	1,881,664	1,838,419	53,511	289,780	558,379	279,366	279,013
Maryland	4,214,195	3,765,239	1,808,472	518,457	494,592	943,718	448,956	206,823	242,133
Wisconsin	3,537,951	3,112,814	592,112	525,128	1,017,293	978,281	425,137	370,034	55,103
Kansas	2,928,527	2,423,216	2,233,306	23,833	79,153	86,924	505,311	308,218	197,093
Missouri	2,881,034	2,252,020	738,975	83,340	1,000,732	429,973	629,014	473,316	155,688
Virginia	1,968,053	1,160,425	3,032	897,574	87,686	172,133	807,628	207,219	600,409
Tennessee	1,816,540	1,352,310	685,211	27,020	367,824	272,255	464,230	290,816	173,414
Oklahoma	1,707,997	1,248,099	1,084,399	2,306	38,692	122,702	459,898	211,655	243,243
Minnesota	1,536,022	1,276,968	30,855	94,811	865,767	285,535	259,054	252,143	6,911
Alabama	1,447,112	898,559	1,985	399,873	299,115	197,586	548,553	376,623	171,930
Louisiana	1,417,933	842,606	298,633	411,393	58,182	74,398	575,327	327,821	247,506
Georgia	1,407,792	1,035,885	346,472	269,087	77,207	343,119	371,907	106,127	265,780
Oregon	1,376,318	1,151,080	1,202	1,015,531	11,387	122,960	225,238	83,652	141,586
North Carolina	1,230,390	831,352	21,614	324,690	66,182	418,876	339,038	46,789	352,249
Maine	1,147,487	1,057,594	20,211	842,909	16,881	177,593	89,893	35,369	54,524
Florida	1,145,967	579,639	2,179	492,364	6,539	78,557	566,328	58,726	507,602
Nebraska	946,604	667,656	563,763	9,638	80,315	13,940	278,948	103,232	175,716
Kentucky	931,380	551,850	206,087	122	93,904	251,737	379,530	212,770	166,760
Iowa	869,667	670,107	648	12,225	425,316	231,918	199,560	156,363	43,197
Rhode Island	866,309	636,596	6,420	41,081	142,090	447,005	229,713	72,492	157,221
West Virginia	642,925	379,616	.....	39,385	129,863	210,368	263,309	255,840	7,469
Mississippi	578,727	345,178	1,013	255,604	42,506	46,055	233,549	45,503	188,046
Utah	563,860	162,806	847	.....	152,162	9,797	401,054	258,152	142,902
Colorado	558,044	260,051	1,366	2,308	180,277	76,100	297,993	124,820	173,173
South Carolina	504,516	311,372	.....	48,974	1,839	260,559	193,144	45,008	148,136
Arkansas	397,126	66,772	.....	.....	46,605	20,167	330,354	220,107	110,247
Arizona	275,260	55,224	32,773	.....	392	22,059	220,036	95,482	124,554
New Hampshire	267,232	217,869	3,002	6,269	2,559	206,039	49,363	31,015	18,348
Delaware	249,711	209,035	15,913	121,630	35,681	35,811	40,676	22,303	18,373
Nevada	223,269	12,608	.....	156	63	12,389	210,661	142,507	68,154
Idaho	122,338	7,354	.....	639	83	6,632	114,984	19,426	95,558
Vermont	120,045	110,658	.....	1,139	456	109,063	9,387	5,903	3,484
New Mexico	102,119	2,937	.....	.....	224	2,713	99,182	4,127	95,055
Dist. of Columbia	98,194	14,375	2,063	994	219	11,099	83,819	30,746	53,073
South Dakota	65,836	2,389	.....	.....	201	2,188	63,447	150	63,297
Montana	63,106	12,611	.....	.....	176	12,435	50,495	12,432	38,063
Wyoming	53,859	15,924	12,197	.....	.....	3,727	37,935	14,762	23,173
North Dakota	4,147	2,545	.....	.....	378	2,167	1,602	30	1,572
Off Continent and Unassigned	17,584,163	11,381,177	2,475,792	495,902	1,514,831	6,894,652	6,202,986	1,219,901	4,983,085
Total Reported	**$175,943,757**	**$146,224,417**	**$47,724,220**	**$22,681,873**	**$33,212,811**	**$42,605,513**	**$29,719,340**	**$15,635,839**	**$14,083,501**

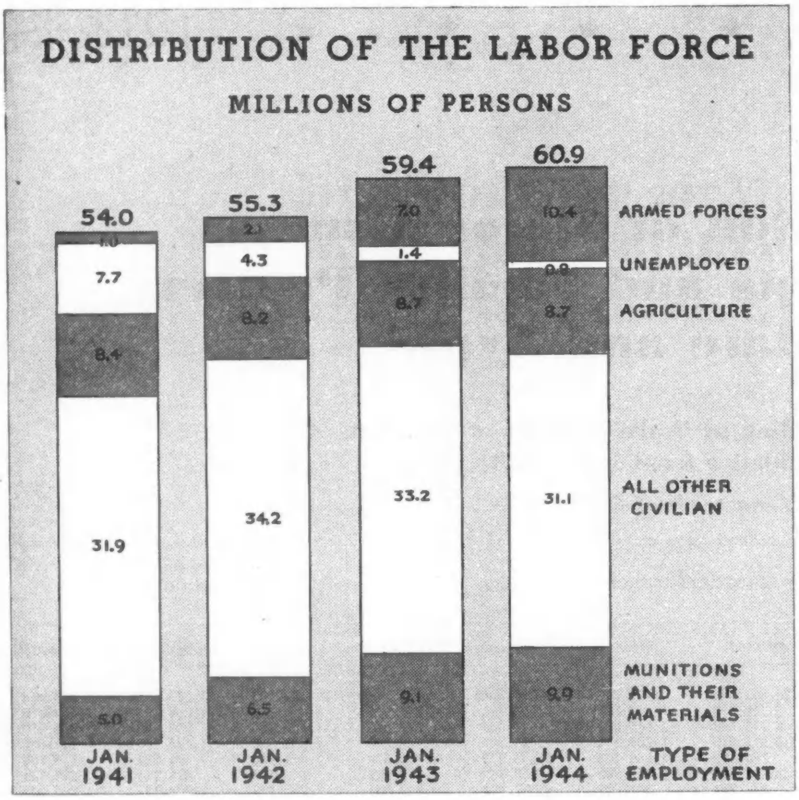
(1)—**War Production Board.**

The category "Aircraft" includes contracts for airframes; airplane engines, propellers and other parts; and certain related equipment such as parachutes and aircraft pontoons. Armament, instruments and communication equipment are excluded.

The category "Ships" includes contracts for the construction of new vessels of all kinds; the purchase of used vessels; ship conversion, recommissioning and repair; and the purchase of marine engines and propulsion equipment. Armor, armament, navigation and radio equipment, parts and materials are excluded.

The category "Ordnance" includes guns, gun mounts, and fire control equipment; ammunition, shells, and bombs, explosives and ammunition loading; and combat vehicles. Armament for airplanes and vessels is included in this category.

THE CIVILIAN

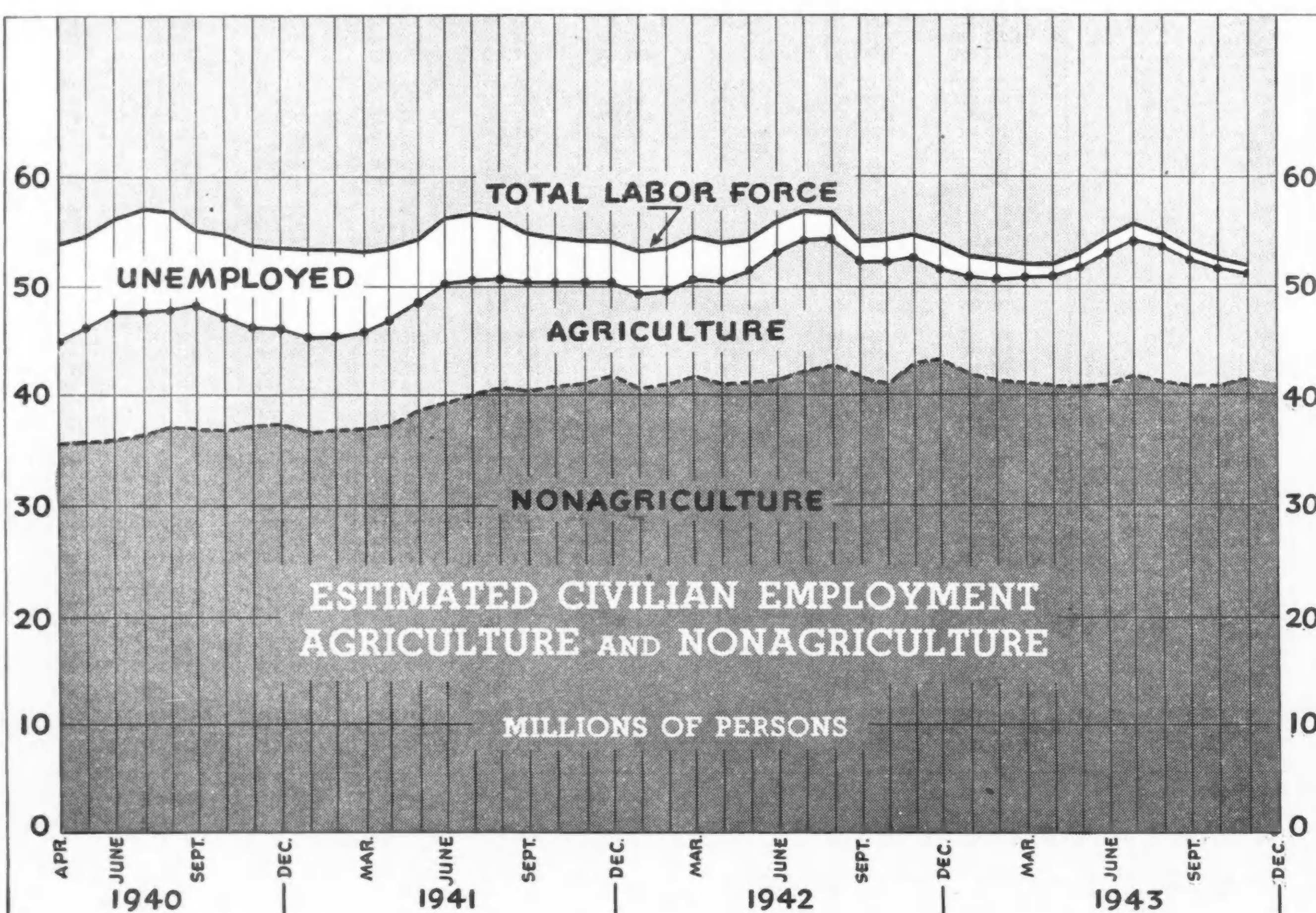


Estimated Civilian Employment*

Agriculture and Nonagriculture
Millions of Persons

Year and Month	Total Labor Force	Agricultural Employment	Nonagricultural Employment	Total Unemployed
April 1940†	53.9	9.0	36.1	8.8
December 1941	54.0	8.3	41.9	3.8
1942				
January	53.2	8.2	40.7	4.3
February	53.4	8.4	41.0	4.0
March	54.5	8.9	42.0	3.6
April	53.7	9.3	41.4	3.0
May	54.2	10.2	41.4	2.6
June	56.1	11.5	41.8	2.8
July	56.8	11.7	42.3	2.8
August	56.2	11.2	42.8	2.2
September	54.1	10.2	42.2	1.7
October	54.0	10.5	41.9	1.6
November	54.5	9.8	43.0	1.7
December	53.4	8.9	43.3	1.5
1943				
January	52.4	8.7	42.3	1.4
February	52.3	8.8	42.1	1.4
March	52.0	9.0	42.0	1.0
April	52.1	9.6	41.6	.9
May	53.0	10.8	41.3	.9
June	54.6	11.9	41.5	1.2
July	55.5	12.1	42.2	1.2
August	54.9	12.0	41.9	1.0
September	53.3	11.3	41.2	.8
October	52.6	10.7	41.2	.7
November	51.9	9.8	41.5	.6
December	....	....	....	....

*—Bureau of Census. †—Actual census count

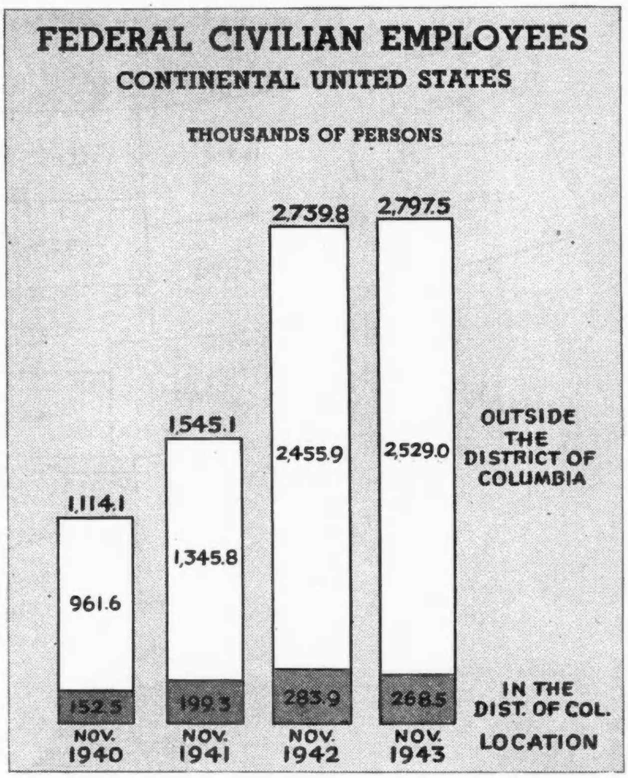


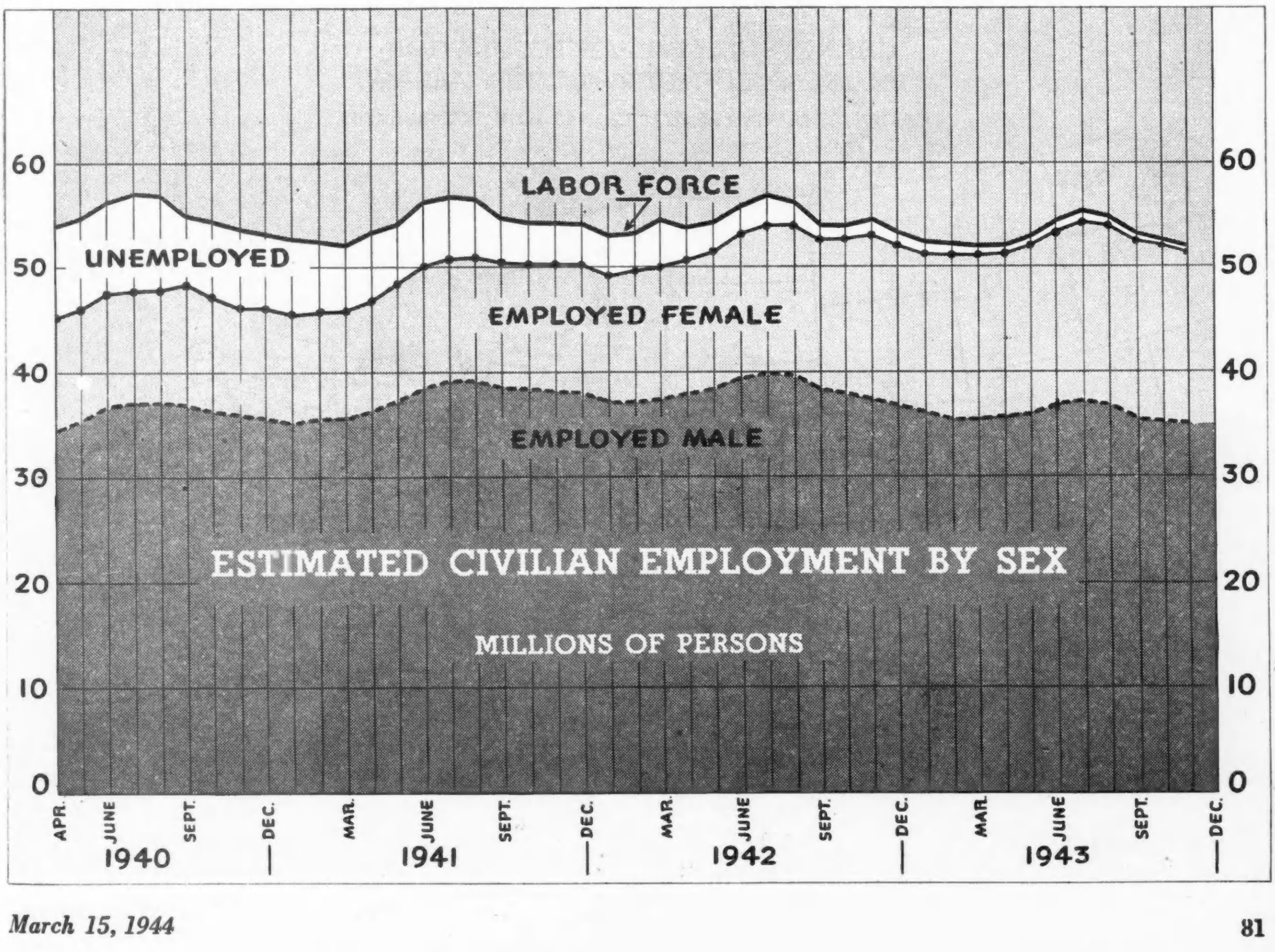
Estimated Civilian Employment by Sex*

Millions of Persons

Year and Month	LABOR FORCE Total	LABOR FORCE Male	LABOR FORCE Female	EMPLOYED Total	EMPLOYED Male	EMPLOYED Female
April, 1940†	53.9	40.6	13.3	45.1	34.1	11.0
December, 1941	54.0	40.2	13.8	50.2	37.6	12.6
1942						
January	53.2	40.0	13.2	48.9	37.0	11.9
February	53.4	40.0	13.4	49.4	37.2	12.2
March	54.5	40.0	14.5	50.9	37.6	13.3
April	53.7	39.8	13.9	50.7	37.8	12.9
May	54.2	40.0	14.2	51.6	38.4	13.2
June	56.1	41.1	15.0	53.3	39.4	13.9
July	56.8	41.6	15.2	54.0	39.9	14.1
August	56.2	41.1	15.1	54.0	39.7	14.3
September	54.1	39.2	14.9	52.4	38.2	14.2
October	54.0	39.0	15.0	52.4	38.1	14.3
November	54.5	38.5	16.0	52.8	37.5	15.3
December	53.4	37.9	15.5	51.9	37.0	14.9
1943						
January	52.4	37.1	15.3	51.0	36.3	14.7
February	52.3	36.7	15.6	50.9	35.9	15.0
March	52.0	36.4	15.6	51.0	35.8	15.2
April	52.1	36.5	15.6	51.2	36.0	15.2
May	53.0	36.7	16.3	52.1	36.2	15.9
June	54.6	37.3	17.3	53.4	36.7	16.7
July	55.5	37.8	17.7	54.3	37.2	17.1
August	54.9	37.5	17.4	53.9	37.0	16.9
September	53.3	36.2	17.1	52.5	35.8	16.7
October	52.6	35.9	16.7	51.9	35.5	16.4
November	51.9	35.6	16.3	51.3	35.3	16.0
December	....	....	....	....	....	....

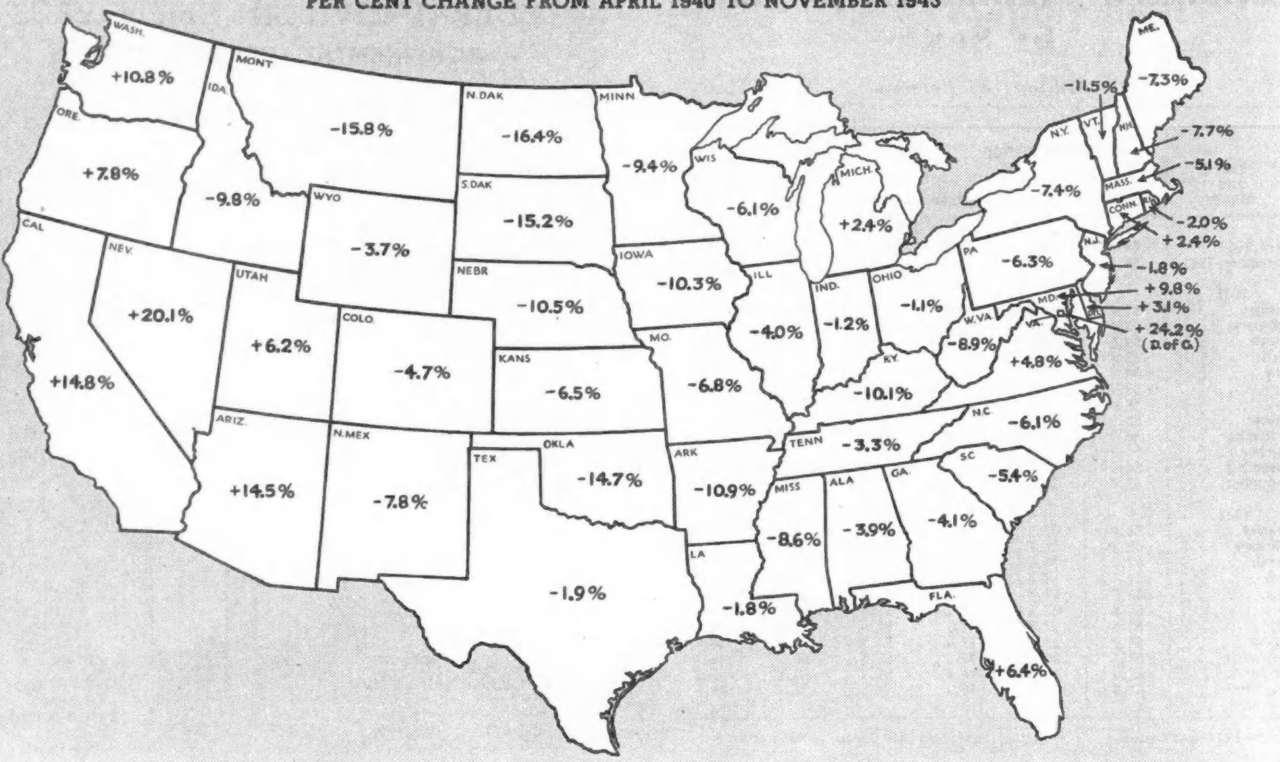
*—Bureau of Census. †—Actual count from 1940 Census of Population.





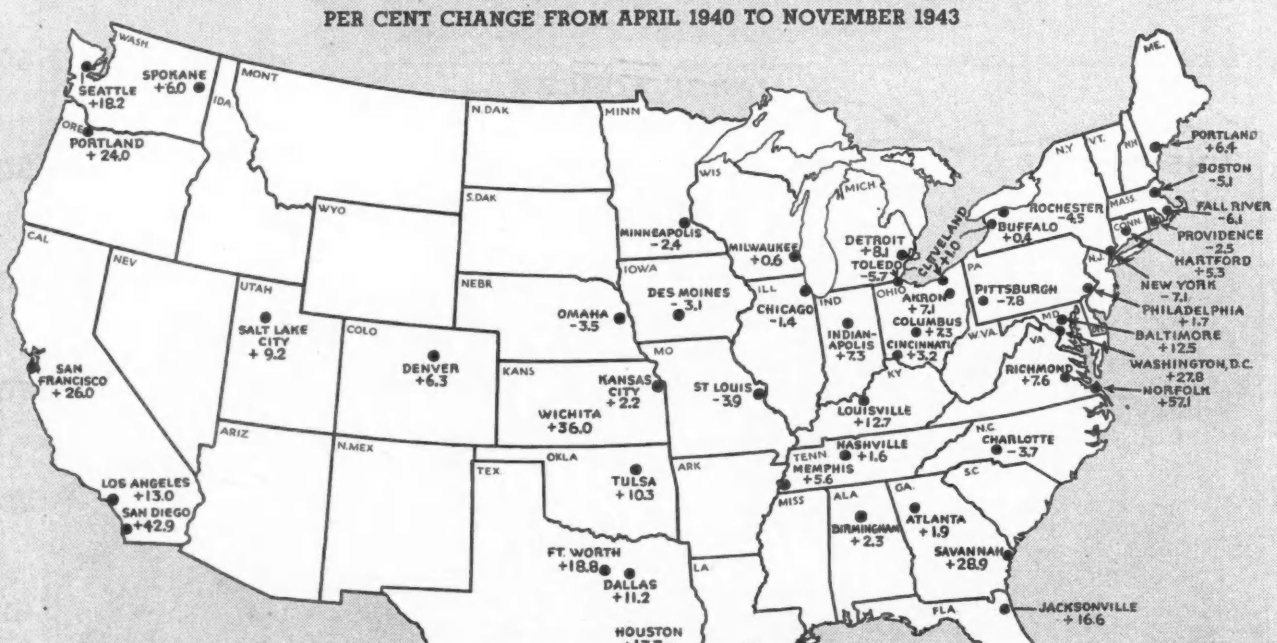
CHANGES IN CIVILIAN POPULATION BY STATES

PER CENT CHANGE FROM APRIL 1940 TO NOVEMBER 1943



CHANGES IN CIVILIAN POPULATION BY SELECTED METROPOLITAN AREAS

PER CENT CHANGE FROM APRIL 1940 TO NOVEMBER 1943



SOURCE—BUREAU OF CENSUS

★ POPULATION CHANGES ★

Population Changes by States

Change from April, 1940, to November, 1943

Arranged in Order of Percentage Change

STATE	Estimated Civilian Population†		Estimated Change in Civilian Population	
	Nov. 1, 1943	April 1, 1940	Number	Per Cent
District of Columbia	816,982	658,018	+158,964	+24.2
Nevada	130,637	108,761	+ 21,876	+20.1
California	7,881,694	6,868,065	+1,013,629	+14.8
Arizona	569,357	497,068	+ 72,289	+14.5
Washington	1,905,239	1,719,145	+186,096	+10.8
Maryland	1,982,947	1,806,485	+176,462	+ 9.8
Oregon	1,172,674	1,088,284	+ 84,390	+ 7.8
Florida	2,012,046	1,891,085	+120,961	+ 6.4
Utah	583,572	549,722	+ 33,850	+ 6.2
Virginia	2,769,828	2,642,729	+127,099	+ 4.8
Delaware	273,614	265,343	+ 8,271	+ 3.1
Connecticut	1,748,402	1,707,406	+ 40,996	+ 2.4
Michigan	5,377,329	5,250,636	+126,693	+ 2.4
Ohio	6,828,352	6,904,423	− 76,071	− 1.1
Indiana	3,383,312	3,424,319	− 41,007	− 1.2
Arkansas	2,316,681	2,358,769	− 42,088	− 1.8
New Jersey	4,080,485	4,153,956	− 73,471	− 1.8
Texas	6,259,584	6,381,862	−122,278	− 1.9
Rhode Island	694,616	708,836	− 14,220	− 2.0
Tennessee	2,818,226	2,915,742	− 97,516	− 3.3
Wyoming	235,739	244,745	− 9,006	− 3.7
Alabama	2,718,273	2,828,166	−109,893	− 3.9
Illinois	7,563,770	7,882,054	−318,284	− 4.0
Georgia	2,976,645	3,102,584	−125,939	− 4.1
Colorado	1,067,095	1,119,274	− 52,179	− 4.7

Source—Bureau of Census.

STATE	Estimated Civilian Population†		Estimated Change in Civilian Population	
	Nov. 1, 1943	April 1, 1940	Number	Per Cent
Massachusetts	4,093,072	4,311,918	−218,846	− 5.1
South Carolina	1,789,662	1,892,742	−103,080	− 5.4
North Carolina	3,346,987	3,562,592	−215,605	− 6.1
Wisconsin	2,945,355	3,137,104	−191,749	− 6.1
Pennsylvania	9,273,342	9,895,697	−622,455	− 6.3
Kansas	1,678,722	1,794,950	−116,228	− 6.5
Missouri	3,524,790	3,783,666	−258,876	− 6.8
Maine	782,312	843,924	− 61,612	− 7.3
New York	12,442,784	13,444,022	−1,001,238	− 7.4
New Mexico	490,119	530,662	− 40,543	− 7.6
New Hampshire	453,333	491,375	− 38,042	− 7.7
Mississippi	1,996,333	2,183,50[illegible]	−187,176	− 8.6
West Virginia	1,732,355	1,901,723	−169,368	− 8.9
Minnesota	2,525,558	2,788,956	−263,398	− 9.4
Idaho	473,166	524,809	− 51,643	− 9.8
Kentucky	2,549,108	2,835,841	−286,733	−10.1
Iowa	2,276,876	2,537,008	−260,132	−10.3
Nebraska	1,176,023	1,313,438	−137,415	−10.5
Arkansas	1,735,564	1,948,250	−212,686	−10.9
Vermont	316,074	357,277	− 41,203	−11.5
Oklahoma	1,987,941	2,329,522	−341,581	−14.7
South Dakota	544,866	642,682	− 97,816	−15.2
Montana	470,033	558,270	− 88,237	−15.8
North Dakota	536,510	641,692	−105,182	−16.4
Totals	127,307,884	131,329,104	−4,021,220	− 3.1

Metropolitan Areas Population Increases

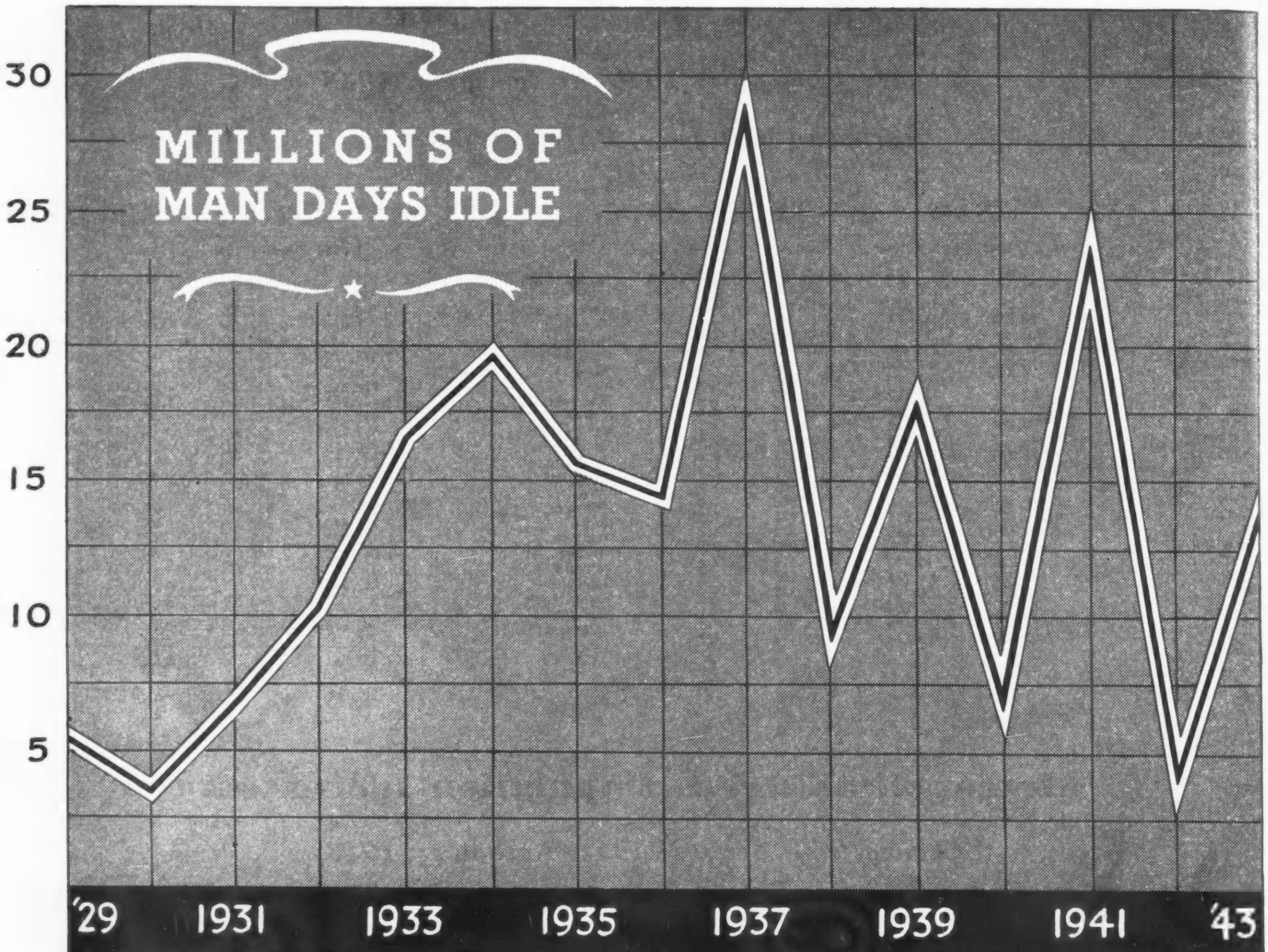
Change from April, 1940, to November, 1943

Arranged According to Percentage Increase

METROPOLITAN AREA	Estimated Civilian Population†		Estimated Increases	
	Nov. 1, 1943	April 1, 1940	Number	Per Cent
Mobile, Ala.	227,763	141,515	88,248	60.9
Norfolk-Portsmouth	....	....	....	....
Newport News, Va.	505,119	321,560	183,559	57.1
San Diego, Calif.	394,569	276,079	118,490	42.9
Charleston, S. C.	161,819	117,694	44,125	37.5
Wichita, Kans.	194,945	143,311	51,634	36.0
Savannah, Ga.	150,111	116,412	33,699	28.9
Washington, D. C.	1,175,384	919,632	255,752	27.8
San Francisco-Oakland, Calif.	1,822,984	1,447,378	375,606	26.0
Portland, Oregon	511,229	412,229	99,000	24.0
Beaumont-Port Arthur, Tex.	178,214	145,296	32,918	22.7
Corpus Christi, Tex.	113,403	92,644	20,759	22.4
Columbus, Ga.	135,980	111,269	24,711	22.2
Macon, Ga.	101,811	83,783	18,028	21.5
Tacoma, Wash.	208,991	173,262	35,729	20.6
Forth Worth, Tex.	267,856	225,521	42,335	18.8
Galveston, Tex.	94,313	79,798	14,516	18.2
Seattle, Wash.	594,793	503,353	91,440	18.2
Jacksonville, Fla.	245,123	210,143	34,980	16.6
San Antonio, Tex.	364,275	315,800	48,475	15.3
Charleston, W. Va.	224,174	195,368	28,806	14.7
Dayton, Ohio	338,688	295,480	43,208	14.6
Evansville, Ind.	179,995	157,766	22,229	14.1
Houston, Tex.	601,249	528,961	72,288	13.7
Stockton, Calif.	151,805	134,207	17,598	13.1
Los Angeles, Calif.	3,292,050	2,913,758	378,292	13.0
Louisville, Ky.	508,719	451,350	57,369	12.7
Baltimore, Md.	1,207,436	1,073,221	134,215	12.5
Columbia, S. C.	117,175	104,839	12,336	11.8
San Jose, Calif.	191,811	172,301	19,510	11.3
Dallas, Tex.	442,967	398,471	44,496	11.2
Sacramento, Calif.	188,168	169,770	18,398	10.8
Tampa-St. Petersburg, Fla.	301,412	272,000	29,412	10.8
Phoenix, Ariz.	206,095	186,193	19,902	10.7
Tulsa, Okla.	213,200	193,363	19,837	10.3
Detroit, Mich.	2,612,115	2,373,823	238,292	10.0
Miami, Fla.	294,445	267,739	26,706	10.0
Knoxville, Tenn.	195,516	178,468	17,048	9.6
Augustus, Ga.	88,871	81,337	7,534	9.3
Salt Lake City, Utah	230,447	211,085	19,362	9.2

METROPOLITAN AREA	Estimated Civilian Population†		Estimated Increases	
	Nov. 1, 1943	April 1, 1940	Number	Per Cent
Fresno, Calif.	194,652	178,565	16,087	+9.0
El Paso, Tex.	136,175	125,868	10,305	+8.2
Richmond, Va.	252,777	235,002	17,775	+7.6
Columbus, Ohio	415,930	387,644	28,286	+7.3
Indianapolis, Ind.	491,053	457,591	33,462	+7.3
New Orleans, La.	584,181	544,510	39,671	+7.3
Akron, Ohio	363,652	339 405	24,247	+7.1
Amarillo, Tex.	58,042	54,265	3,777	+7.0
South Bend, Ind.	173,111	161,823	11,288	+7.0
Portland, Me.	152,877	143,686	9,191	+6.4
Pueblo, Colo.	73,268	68,870	4,398	+6.4
Denver, Colo.	405,274	381,267	24,007	+6.3
Little Rock, Ark.	165,771	156,020	9,751	+6.2
Wilmington, Del.	189,532	179,483	11,049	+6.2
Spokane, Wash.	172,352	162,620	9,732	+6.0
Memphis, Tenn.	378,108	358,151	19,957	+5.6
Canton, Ohio	247,668	234,887	12,781	+5.4
Hartford-New Britain, Conn.	532,921	506,188	26,733	+5.3
Oklahoma City, Okla.	256,559	244,159	12,400	+5.1
Springfield, Ohio	100,466	95,647	4,819	+5.0
Lansing, Mich.	135,958	130,616	5,342	+4.1
Rockford, Ill.	126,110	121,115	4,995	+4.1
St. Louis, Mo.	1,485,868	1,429,443	56,425	+3.9
Bridgeport, Conn.	434,265	418,384	15,881	+3.8
Madison, Wisc.	135,232	130,660	4,572	+3.5
Montgomery, Ala.	115,246	111,428	3,818	+3.4
Jackson, Miss.	110,836	107,273	3,563	+3.3
Cincinnati, Ohio	834,281	808,156	26,125	+3.2
Hamilton-Middletown, Ohio	123,344	120,249	3,095	+2.6
Erie, Penna.	185,179	180,813	4,366	+2.4
Birmingham, Ala.	470,383	459,930	10,453	+2.3
Kansas Cities, Mo. and Kans.	670,575	656,225	14,350	+2.2
Atlanta, Ga.	486,362	477,261	9,101	+1.9
Davenport, Iowa-Rock Island.	201,244	197,673	3,571	+1.8
Kalamazoo, Mich.	101,716	100,060	1,656	+1.7
Philadelphia-Camden	3,002,565	2,953,124	49,441	+1.7
Nashville, Tenn.	261,258	257,267	3,991	+1.6
Cleveland, Ohio	1,228,803	1,216,859	11,944	+1.0
Saginaw-Bay, Mich.	206,551	205,449	1,102	+0.5
Buffalo-Niagara, N. Y.	961,345	957,677	3,668	+0.4

† Estimated civilian population in 1940 was derived by subtracting from total population the number of persons returned in the census as members of the armed forces. November, 1943, estimates are based on registrations for War Ration Book Four.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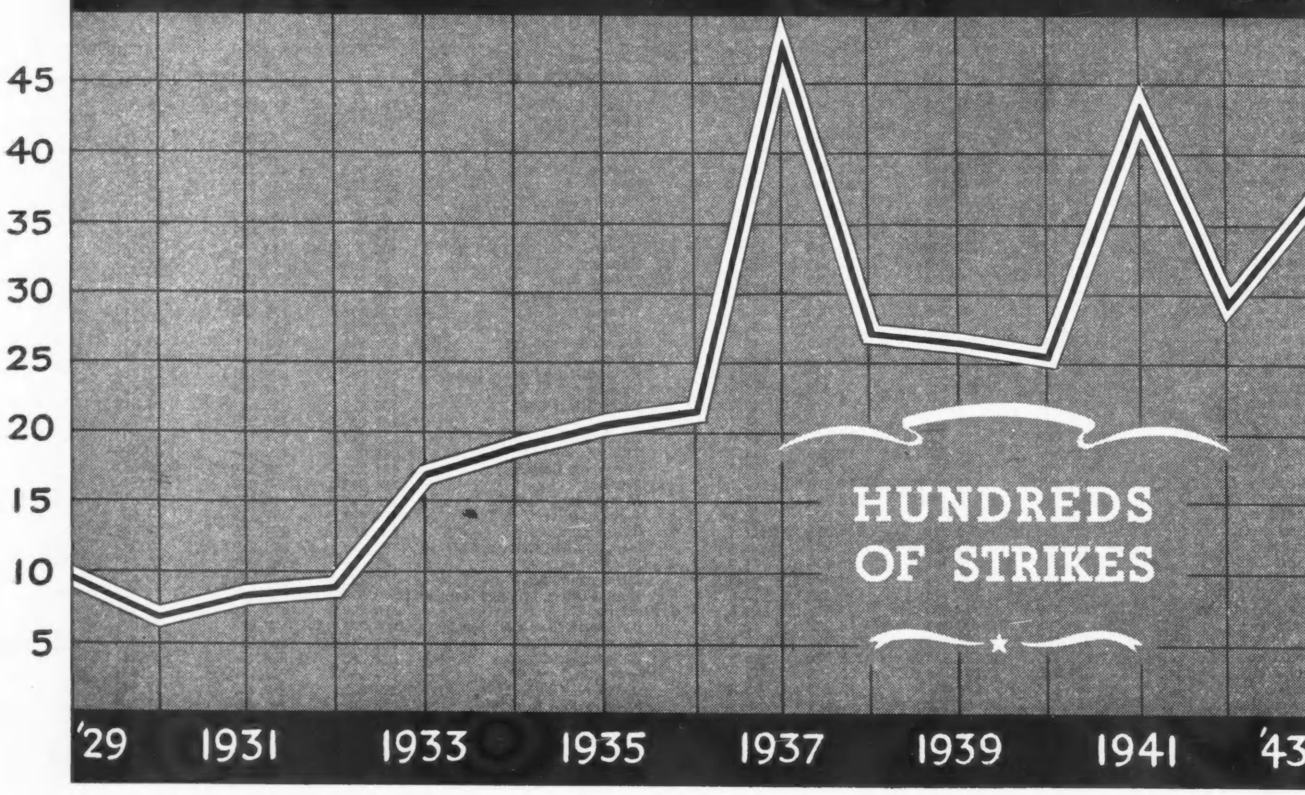
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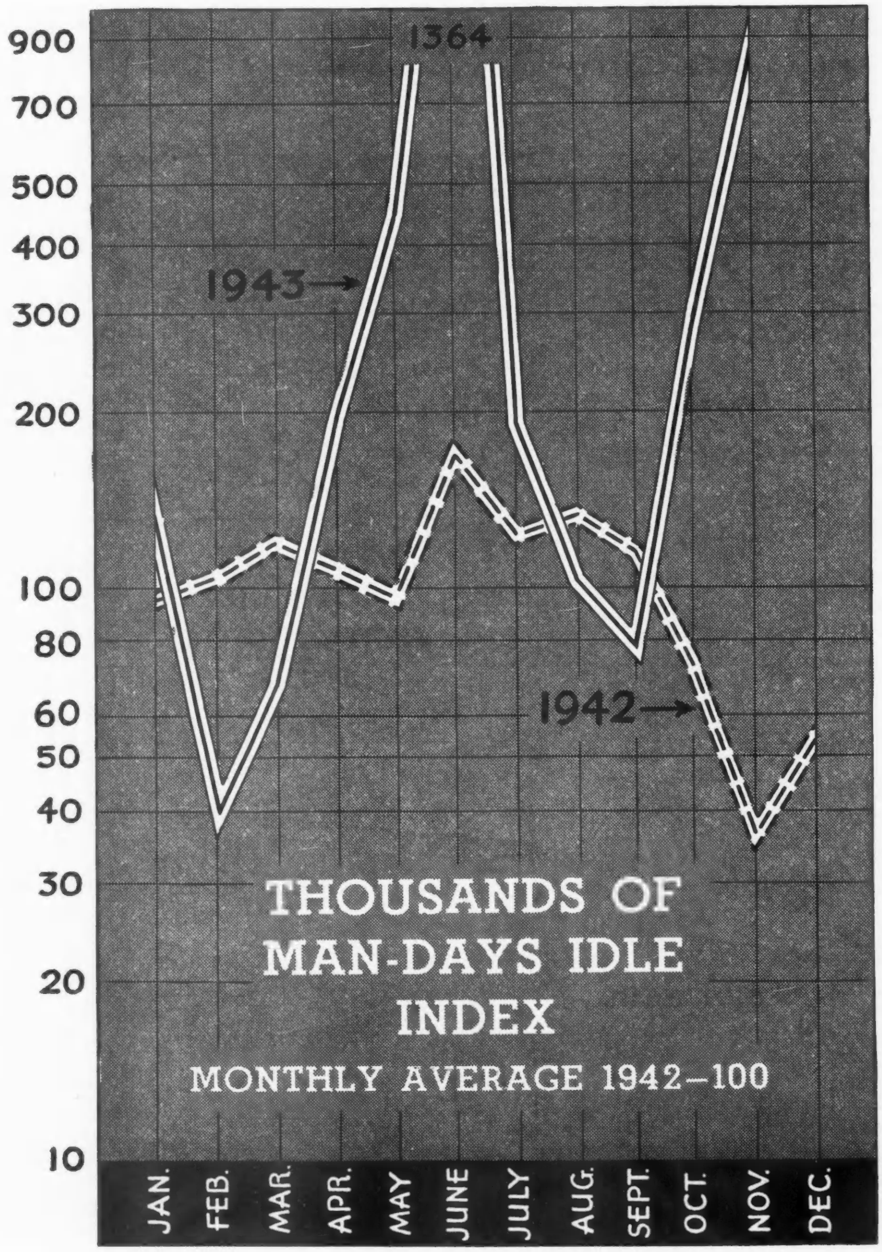
Strikes in All Industry—By Years—1928-1943*

	Number of Strikes	Workers Involved	Workers per Strike	Man Days Idle	Average Man Days Lost Per Strike	Per Worker Involved
1928	604	314,210	520	12,631,863	20,914	40
1929	921	288,572	313	5,351,540	5,811	19
1930	637	182,975	287	3,316,808	5,207	18
1931	810	341,817	422	6,893,244	8,510	20
1932	841	324,210	386	10,502,033	12,488	32
1933	1,695	1,168,272	689	16,872,128	9,954	14
1934	1,856	1,466,695	790	19,591,949	10,556	13
1935	2,014	1,117,213	555	15,456,337	7,674	14
1936	2,172	788,648	363	13,901,956	6,401	18
1937	4,740	1,860,621	393	28,424,857	5,997	15
1938	2,772	688,376	248	9,148,273	3,300	13
1939	2,613	1,170,962	448	17,812,219	6,817	15
1940	2,508	576,988	230	6,700,872	2,672	12
1941	4,288	2,362,620	551	23,047,556	5,375	10
1942	2,968	839,961	283	4,182,557	1,409	5
1943†	3,425	3,059,000	893	12,785,000	3,732	4

* Source—Bureau of Labor Statistics. † Eleven months data.



Strikes in All Industry* By Months

	Number of Strikes †	Man-Days Idle
1941		
January	240	663,185
February	257	1,134,531
March	348	1,558,457
April	403	7,112,742
May	463	2,172,303
June	357	1,504,056
July	439	1,325,758
August	465	1,825,488
September	470	1,952,652
October	432	1,925,328
November	271	1,396,585
December	143	476,471
Total	4,288	23,047,556
1942		
January	156	330,567
February	181	357,333
March	234	401,739
April	277	367,400
May	285	322,085
June	345	586,408
July	388	416,741
August	330	448,712
September	274	387,150
October	207	243,756
November	144	128,164
December	147	192,502
Total	2,968	4,182,557
1943		
January	195	450,000
February	210	140,000
March	260	230,000
April	395	675,000
May	395	1,500,000
June	425	4,750,000
July	375	690,000
August	335	355,000
September	245	195,000
October	290	975,000
November	300	2,825,000
December	.....	....
Total‡	3,425	12,785,000

†—Beginning in the month.
‡—Eleven Months.
*—Bureau of Labor Statistics.

★ Income Payments to Individuals* ★ ★

(Millons of Dollars)

	1939	1940	1941	1942	1943
Salaries and Wages	$45,658	$49,761	$61,446	$79,889	$100,603
Direct and Other Relief	1,071	1,098	1,112	1,061	939
Social Security Benefits and Other Labor Income	1,768	1,951	1,879	2,053	2,793
Dividends and Interest	8,891	9,175	9,653	9,331	9,940
Entrepreneurial Income, Net Rents, Royalties	13,441	14,484	18,139	23,145	27,442
Total—Income Payments	$70,829	$76,472	$92,229	$115,479	$141,717
Total Nonagricultural Income	$64,779	$70,314	$83,758	$102,929	$125,478
Total Cash Farm Income, including Government Payments	$8,684	$9,145	$11,830	$15,357	$19,695

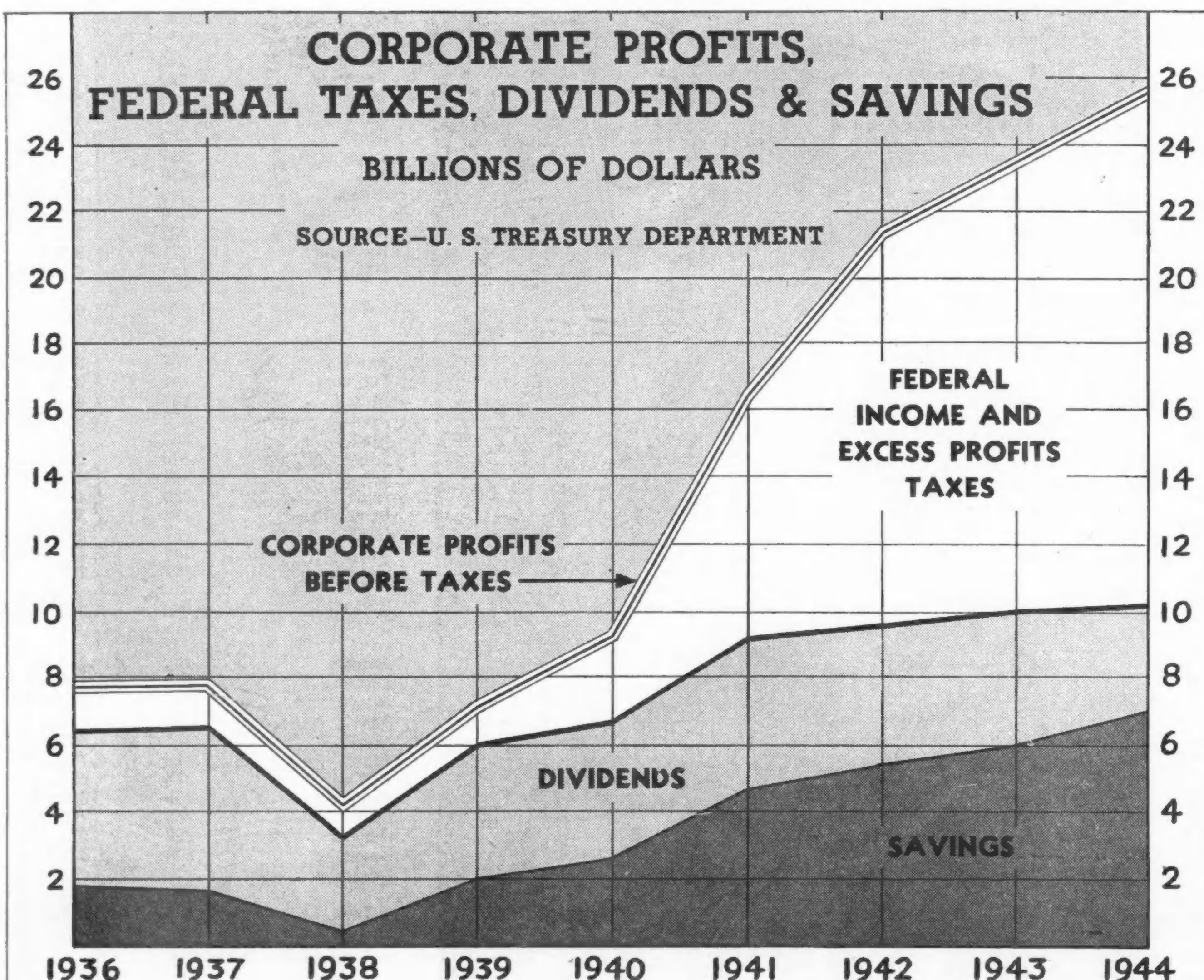
*—U. S. Department of Commerce.

Corporate Profits Before and After Federal Taxes

(In Millions of Dollars)

	1936	1937	1938	1939	1940	1941(1)	1942(2)	1943(2)	1944(2)
Corporate Profits before Taxes	$7,771	$7,830	$4,131	$7,178	$9,225	$16,345	$21,400	$23,500	$25,600
Federal Income and Excess Profits Taxes	1,191	1,276	860	1,232	2,549	7,166	11,750	13,450	14,600
Corporate Profits after Federal Taxes	$6,580	$6,554	$3,271	$5,946	$6,676	$9,179	$9,650	$10,050	$11,000
Net Dividends Paid	4,703	4,832	3,222	3,841	4,068	4,463	4,100	4,000	4,100
Savings	$1,877	$1,722	$49	$2,105	$2,608	$4,716	$5,550	$6,050	$6,900

Source—U. S. Treasury Department, Division of Research and Statistics. (1)—Preliminary. (2)—Estimated.



★ ★ Public Debt of the United States ★

(Gross Debt in Thousands of Dollars)

Year Ending June 30	Gross Debt	Debt per Capita	Year Ending June 30	Gross Debt	Debt per Capita	Year Ending June 30	Gross Debt	Debt per Capita
1900	$1,263,417	$16.56	1915	$1,191,264	$11.83	1930	$16,185,308	$131.49
1901	1,221,572	15.71	1916	1,225,146	11.96	1931	16,801,485	135.37
1902	1,178,031	14.89	1917	2,975,619	28.57	1932	19,487,010	155.93
1903	1,159,406	14.40	1918	12,243,629	115.65	1933	22,538,672	179.21
1904	1,136,259	13.88	1919	25,482,034	240.09	1934	27,053,086	213.65
1905	1,132,357	13.60	1920	24,297,918	228.32	1935	28,701,167	225.07
1906	1,142,523	13.50	1921	23,976,251	221.09	1936	33,545,385	261.20
1907	1,147,178	13.33	1922	22,964,079	208.97	1937	36,427,091	281.82
1908	1,177,690	13.46	1923	22,349,688	200.10	1938	37,167,487	285.43
1909	1,148,315	12.91	1924	21,251,120	186.86	1939	40,445,417	308.34
1910	1,146,940	12.69	1925	20,516,272	177.82	1940	42,971,044	325.66
1911	1,153,985	12.28	1926	19,643,183	167.70	1941	48,978,919	367.68
1912	1,193,839	12.48	1927	18,510,174	156.04	1942	72,495,183	540.68
1913	1,193,048	12.26	1928	17,604,291	146.69	1943	136,696,000*	1,007.64*
1914	1,188,235	12.00	1929	16,931,198	139.40	1944	197,600,000*	1,486.00*

Source—U. S. Department of Commerce. *—Estimate from the Budget of the U. S. Government.

Federal Internal Revenue Receipts by Tax Sources*

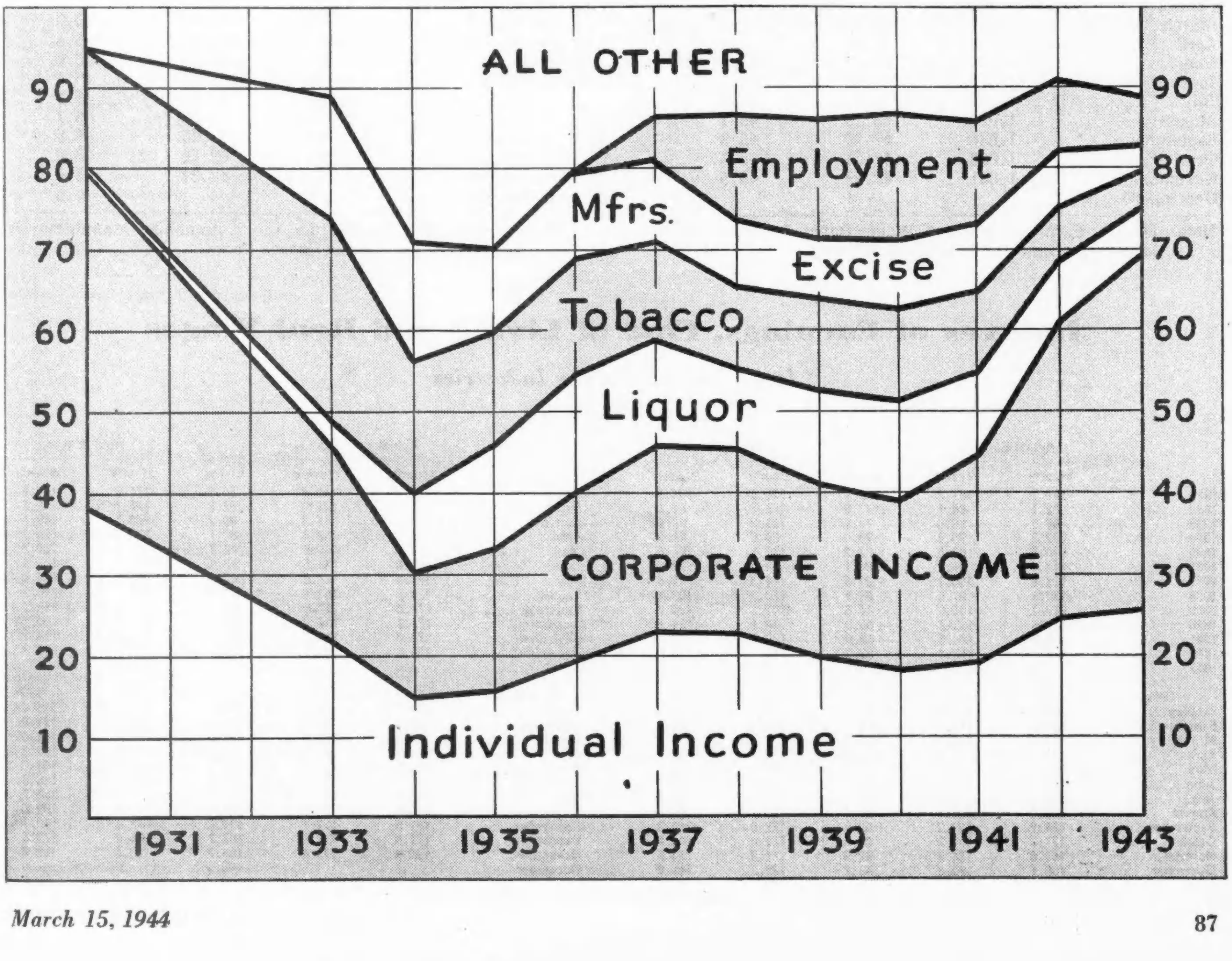
(Thousands of Dollars)

Year Ending June 30	Income Taxes Individual	Income Taxes All Other†	Liquor Taxes	Tobacco Taxes	Manufacturers' Excise Taxes	Employment Taxes	All Other Taxes	Total Receipts
1938	$1,286,312	$1,299,932	$567,979	$568,182	$417,200	$742,660	$776,500	$5,658,765
1939	1,028,834	1,122,541	587,800	580,159	396,982	740,429	724,829	5,181,574
1940	982,017	1,120,582	624,253	608,518	447,226	833,521	724,335	5,340,452
1941	1,417,655	1,851,988	820,056	698,077	617,374	925,856	1,039,102	7,370,108
1942	3,262,800	4,687,462	1,048,517	780,982	852,000	1,185,362	1,230,746	13,047,869
1943	5,739,434	9,673,942	1,424,000	924,000	670,000	1,499,987	2,407,921	22,339,284

Source—Treasury Department, Bureau of Internal Revenue. †—Includes Corporation Income, Excess Profits, Capital Stock Taxes, etc.

Federal Internal Revenue by Tax Sources 1930—1943

(Shown as Percentage of Total Tax Revenue)



Earnings and Hours Worked in Manufacturing Industries

Source: National Industrial Conference Board

25 MANUFACTURING INDUSTRIES

Year and Month	Average Earnings		Average Actual Hours per Week per Wage Earner
	Hourly	Weekly	
1929	$.590	$28.55	48.3
1932	.498	17.05	34.8
1933	.491	17.71	36.4
1934	.580	20.06	34.7
1935	.599	22.23	37.2
1936	.619	24.39	39.5
1937	.695	26.80	38.7
1938	.716	24.43	34.3
1939	.720	27.04	37.6
1940	.739	28.54	38.6
1941	.814	33.62	41.2
1942	.924	40.03	43.0
1943	.956	42.66	44.3
1942			
January	.878	37.47	42.4
February	.880	37.53	42.4
March	.888	38.14	42.7
April	.895	38.68	42.8
May	.906	39.00	42.7
June	.917	39.52	42.7
July	.928	39.80	42.6
August	.940	40.87	43.2
September	.957	41.79	43.4
October	.958	42.10	43.6
November	.966	42.50	43.7
December	.970	42.98	44.2
1943			
January	.979	43.56	44.3
February	.982	43.85	44.5
March	.987	44.30	44.7
April	.998	45.02	44.9
May	1.009	45.92	45.3
June	1.016	46.16	45.2
July	1.020	46.14	45.0
August	1.020	46.25	45.1
September	1.036	47.12	45.3
October	1.036	47.51	45.5
November	1.041	47.59	45.5
December	.....	.....	....

Note—Hourly Earnings are not Wage Rates because they include overtime and incentive payments.

AUTOMOBILE INDUSTRY*

Year and Month	Average Earnings		Average Actual Hours per Week per Wage Earner
	Hourly	Weekly	
1929	$.695	$32.48	46.8
1932	.609	18.50	30.4
1933	.609	21.84	36.0
1934	.715	23.69	33.2
1935	.752	28.04	37.4
1936	.791	29.81	37.7
1937	.916	32.31	35.3
1938	.953	30.77	32.3
1939	.953	33.26	34.9
1940	.971	36.22	37.3
1941	1.086	42.33	39.0
1942	1.248	55.55	44.4
1943	1.296	59.47	45.8
1942			
January	1.251	54.17	42.8
February	1.244	54.49	43.1
March	1.246	56.69	45.6
April	1.242	56.14	45.2
May	1.245	56.27	44.9
June	1.237	54.80	44.3
July	1.241	54.11	43.6
August	1.235	56.65	45.9
September	1.260	55.28	43.9
October	1.239	56.52	45.6
November	1.273	57.44	45.1
December	1.267	54.13	42.7
1943			
January	1.299	59.56	45.9
February	1.271	58.63	46.1
March	1.283	58.36	45.5
April	1.281	58.42	45.6
May	1.298	60.88	46.9
June	1.302	59.16	45.4
July	1.302	59.60	45.8
August	1.289	58.88	45.7
September	1.311	58.46	44.6
October	1.303	62.59	48.0
November	1.310	59.52	45.4
December	.....	.....	....

*Based on data collected by the Automobile Manufacturers Association and the Conference Board.

Indexes of Earnings, Cost of Living and Real Wages

In 25 Manufacturing Industries

Index, 1923 = 100

	Actual Earnings		Cost of Living	Real Wages	
	Hourly	Weekly		Hourly	Weekly
1929	109.1	107.3	100.1	108.9	107.1
1932	92.1	64.1	77.9	118.2	82.3
1933	90.8	66.6	74.9	121.2	88.9
1934	107.2	75.4	79.4	135.0	95.0
1935	110.7	83.5	82.2	132.5	101.6
1936	114.4	91.7	84.1	136.0	109.0
1937	128.5	100.7	87.8	146.3	114.6
1938	132.3	91.8	85.7	154.3	107.1
1939	133.1	101.6	84.5	157.5	120.2
1940	136.6	107.3	85.3	160.1	125.7
1941	150.5	126.3	89.0	169.1	141.9
1942	170.8	150.4	97.7	174.8	153.9
1943	.....	.....	.....	.....	.....
1941					
January	140.3	115.0	86.0	163.1	133.7
February	141.2	118.0	86.1	164.0	137.0
March	142.1	119.5	86.3	164.7	138.5
April	144.9	119.8	86.9	166.7	137.9
May	147.7	124.5	87.4	169.0	142.4
June	151.2	128.7	88.5	170.8	145.4
July	151.9	126.6	88.9	170.9	142.4
August	153.0	128.1	89.4	171.1	143.3
September	156.2	131.9	90.8	172.0	145.3
October	157.7	134.0	92.0	171.4	145.7
November	159.0	134.3	92.9	171.2	144.6
December	160.4	135.6	93.2	172.1	145.5
1942					
January	162.3	140.8	94.5	171.7	149.0
February	162.7	141.0	95.3	171.1	148.3
March	164.1	143.3	96.2	170.8	149.1
April	165.6	145.4	97.1	170.5	149.7
May	167.5	146.6	97.3	172.1	150.7
June	169.5	148.5	97.4	174.2	152.6
July	171.5	149.6	97.8	175.4	153.0
August	173.8	153.6	98.1	177.2	156.6
September	176.9	157.0	98.8	179.4	159.2
October	177.1	158.2	99.2	177.6	158.7
November	178.6	159.7	100.5	178.1	159.2
December	179.3	161.5	101.1	177.5	159.9
1943					
January	181.0	163.7	101.5	178.5	161.4
February	181.5	164.8	101.9	178.3	161.9
March	182.4	166.5	102.0	177.4	162.0
April	184.5	169.2	104.0	177.9	163.2
May	186.5	172.6	104.2	179.3	166.0
June	187.8	173.5	104.3	180.6	166.8
July	188.5	173.4	103.1	183.4	168.7
August	188.5	173.8	102.8	183.9	169.6
September	191.5	177.1	103.1	186.1	172.1
October	191.5	178.5	103.7	185.0	172.5
November	192.4	178.8	103.7	185.9	172.8
December	.....	.....	103.9	.....	.....

HOURS WORKED ★ ★

Average Actual Hourly Earnings in Manufacturing Industries

Note: Hourly Earnings are not wage rates, because they include overtime and incentive payments.

INDUSTRY	1929	1932	1935	1936	1937	1938	1939	1940	1941	1942	1943
Agricultural Implement	$.625	$.546	$.666	$.675	$.777	$.800	$.805	$.817	$.901	$1.901	$1.086
Automobile	.695	.609	.752	.791	.916	.953	.953	.971	1.083	1.248	1.296
Boot and Shoe	.501	.405	.570	.567	.546	.542	.521	.535	.589	.668	.701
Chemical	.574	.485	.606	.623	.722	.748	.757	.787	.851	.944	1.037
Cotton—North	.420	.333	.448	.452	.514	.500	.491	.511	.564	.671	.748
Electrical Manufacturing	.627	.594	.667	.669	.756	.801	.796	.813	.900	1.009	1.067
Furniture	.551	.448	.537	.550	.619	.653	.661	.681	.756	.850	.952
Hosiery and Knit Goods	.496	.397	.520	.511	.556	.573	.546	.557	.578	.666	.767
Iron and Steel	.654	.531	.655	.670	.818	.830	.841	.850	.958	1.037	1.135
Leather Tanning and Finishing	.524	.459	.555	.563	.621	.635	.643	.658	.708	.803	.859
Lumber and Millwork	.580	.412	.495	.599	.660	.692	.673	.690	.797	.927	1.059
Meat Packing	.516	.431	.570	.566	.672	.695	.696	.693	.748	.817	.878
Paint and Varnish	.583	.517	.575	.615	.689	.707	.719	.731	.789	.868	.927
Paper and Pulp	.541	.468	.533	.545	.620	.645	.641	.668	.725	.817	.876
Paper Products	.530	.464	.523	.526	.568	.603	.611	.628	.666	.752	.807
Printing—Book and Job	.725	.710	.736	.724	.749	.790	.823	.826	.846	.884	.957
Printing—News and Magazines	.884	.786	.862	.875	.912	.950	.966	.978	.987	1.019	1.089
Rubber	.661	.599	.801	.756	.847	.841	.863	.876	.927	1.010	1.123
Silk and Rayon	.487	.385	.527	.507	.516	.526	.518	.529	.554	.639	.728
Wool	.483	.385	.516	.531	.608	.608	.595	.623	.688	.794	.879
Foundries and Machine Shops	.608	.524	.594	.611	.699	.728	.738	.761	.850	.999	1.107

Source—National Industrial Conference Board.

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Average Actual Weekly Earnings in Manufacturing Industries, 1932–1943

INDUSTRY	1929	1932	1935	1936	1937	1938	1939	1940	1941	1942	1943
Agricultural Implement	$31.02	$17.96	$26.42	$26.78	$31.08	$28.08	$30.56	$32.12	$37.33	$43.47	$50.55
Automobile	32.48	18.50	28.04	29.81	32.31	30.77	33.26	36.22	42.45	55.51	59.47
Boot and Shoe	22.16	16.67	21.15	20.89	20.89	17.78	18.74	18.12	22.21	25.88	27.94
Chemical	28.87	19.68	23.79	24.86	28.74	27.97	29.71	31.36	34.96	39.45	46.80
Cotton—North	20.20	14.10	16.31	17.34	19.44	17.89	18.56	19.14	22.47	28.21	32.51
Electrical Manufacturing	29.66	17.43	24.14	26.22	29.32	27.06	30.36	32.95	39.35	46.47	49.60
Furniture	25.82	15.04	20.32	22.96	24.95	23.00	25.37	26.69	31.88	37.01	45.32
Hosiery and Knit Goods	23.58	15.26	17.96	18.28	20.30	19.46	19.98	19.75	21.41	25.51	31.40
Iron and Steel	35.90	14.51	22.42	26.65	29.92	22.91	29.09	30.69	36.98	40.41	48.81
Leather Tanning and Finishing	24.91	18.74	21.11	22.01	23.67	22.57	24.84	24.61	28.66	32.25	36.84
Lumber and Millwork	26.32	14.97	19.48	24.39	25.90	25.36	26.68	27.38	32.48	40.25	48.10
Meat Packing	26.12	20.77	23.14	23.71	26.75	28.13	27.94	27.77	29.25	32.61	40.55
Paint and Varnish	30.17	21.43	22.90	27.86	28.32	27.61	29.24	29.45	32.79	38.36	43.76
Paper and Pulp	28.21	18.98	21.07	23.20	26.06	24.83	26.10	27.52	31.28	35.21	41.28
Paper Products	26.23	19.03	20.00	21.56	23.26	23.08	24.42	24.74	27.61	31.04	35.57
Printing—Book and Job	33.34	27.31	28.28	28.81	30.27	30.09	32.28	33.33	34.79	36.83	41.11
Printing—News and Magazines	40.35	33.17	31.18	32.56	34.55	34.71	35.72	36.43	37.51	39.61	43.75
Rubber	29.58	19.87	26.52	27.64	28.16	25.52	30.65	31.01	35.65	41.41	51.11
Silk and Rayon	23.25	14.94	16.89	17.33	18.22	16.96	18.23	18.24	20.80	25.88	30.69
Wool	22.39	15.09	18.91	19.19	21.03	19.62	21.31	22.34	27.44	32.42	37.79
Foundries and Machine Shops	30.00	15.77	22.46	25.30	28.85	24.98	28.55	31.56	38.93	47.51	52.97

Source—National Industrial Conference Board.

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Average Actual Hours Per Week Per Wage Earner by Years

INDUSTRY	1929	1932	1935	1936	1937	1938	1939	1940	1941	1942	1943
Agricultural Implement	49.6	32.9	39.7	39.7	40.0	35.1	38.0	39.3	41.5	43.3	46.5
Automobile	46.8	30.4	37.4	37.7	35.3	32.3	34.9	37.3	39.2	44.5	45.8
Boot and Shoe	44.2	41.1	37.1	36.8	38.3	32.8	36.0	33.9	37.7	38.8	39.8
Chemical	50.4	40.7	39.3	39.9	39.8	37.4	39.3	39.9	41.1	41.8	45.1
Cotton—North	48.2	42.5	36.4	38.4	37.9	35.7	37.8	37.5	39.8	42.0	43.4
Electrical Manufacturing	47.4	29.4	36.2	39.2	38.8	33.8	38.2	40.5	43.7	46.0	46.5
Furniture	46.9	33.6	37.8	41.8	40.4	35.3	38.4	39.2	42.2	43.5	47.5
Hosiery and Knit Goods	47.6	38.5	34.5	35.8	36.6	34.0	36.6	35.4	37.1	38.2	40.8
Iron and Steel	54.9	27.2	34.2	39.8	36.6	27.6	34.6	36.1	38.6	39.0	42.9
Leather Tanning and Finishing	47.6	40.9	38.1	39.1	38.2	35.6	38.6	37.4	40.5	41.4	42.8
Lumber and Millwork	45.4	36.4	39.3	40.7	39.3	36.6	39.6	39.7	40.7	43.3	45.2
Meat Packing	50.6	48.2	40.6	41.9	39.8	40.5	40.1	40.1	39.1	39.9	45.3
Paint and Varnish	51.8	41.4	39.9	45.3	41.2	39.0	40.7	40.3	41.5	41.9	47.0
Paper and Pulp	52.1	40.6	39.6	42.6	42.1	38.5	40.7	41.2	43.1	43.1	47.0
Paper Products	49.5	41.1	38.2	41.0	41.0	38.3	40.0	39.4	41.4	41.3	44.1
Printing—Book and Job	46.0	38.5	38.4	39.8	40.4	38.1	39.2	40.3	41.1	41.6	43.0
Printing—News and Magazines	45.7	42.1	36.2	37.2	37.9	36.6	37.0	37.3	38.0	38.8	40.1
Rubber	44.8	33.1	33.1	36.6	33.3	30.3	35.5	35.4	38.5	40.9	45.5
Silk and Rayon	47.8	38.9	32.1	34.2	35.3	32.3	35.2	34.4	37.6	40.4	42.0
Wool	46.4	39.3	36.7	36.1	34.7	32.4	35.8	35.9	39.9	40.8	43.0
Foundries and Machine Shops	49.4	30.1	37.8	41.4	41.4	34.3	38.6	41.4	45.8	47.6	47.9

Source—National Industrial Conference Board.

COST OF LIVING ★ ★

Wholesale Commodity Prices

Index 1926 = 100

	Composite All Commodities	Manufactured Products	Raw Materials	Semi-manufactured Products	Farm Products	Foods
1929	95.3	94.5	97.5	93.9	104.9	99.9
1930	86.4	88.0	84.3	81.8	88.3	90.5
1931	73.0	77.0	65.6	69.0	64.8	74.6
1932	64.8	70.3	55.1	59.3	48.2	61.0
1933	65.9	70.5	56.5	65.4	51.4	60.5
1934	74.9	78.2	68.6	72.8	65.3	70.5
1935	80.0	82.2	77.1	73.6	78.8	83.7
1936	80.8	82.0	79.9	75.9	80.9	82.1
1937	86.3	87.2	84.8	85.3	86.4	85.5
1938	78.6	82.2	72.0	75.4	68.5	73.6
1939	77.1	80.4	70.2	77.0	65.3	70.4
1940	78.6	81.6	71.9	79.1	67.7	71.3
1941	87.3	89.1	83.5	86.9	82.4	82.7
1942	98.7	98.5	100.6	92.6	105.9	99.6
1943	103.2	100.2	112.1	92.9	122.7	106.8
1942						
January	96.0	96.4	96.1	91.7	100.8	93.7
February	96.7	97.0	97.0	92.0	101.3	94.6
March	97.6	97.8	98.2	92.3	102.8	96.1
April	98.8	98.7	100.0	92.8	104.5	98.7
May	98.8	99.0	99.7	92.9	104.4	98.9
June	98.6	98.6	99.8	92.8	104.4	99.3
July	98.7	98.6	100.1	92.8	105.3	99.2
August	99.2	98.9	101.2	92.7	106.1	100.8
September	99.6	99.2	102.2	92.9	107.8	102.4
October	100.0	99.4	103.0	92.7	109.0	103.4
November	100.3	99.4	103.9	92.6	110.5	103.5
December	101.0	99.6	106.1	92.5	113.8	104.3
1943						
January	101.9	100.1	108.2	92.8	117.0	105.2
February	102.5	100.3	109.6	92.9	119.0	105.8
March	103.4	100.5	112.0	93.0	122.8	107.4
April	103.7	100.6	112.8	93.1	123.9	108.4
May	104.1	100.7	114.0	93.0	125.7	110.5
June	103.8	100.1	114.3	92.8	126.2	109.6
July	103.2	99.6	113.6	92.8	125.0	107.2
August	103.1	99.7	112.7	92.9	123.5	105.8
September	103.1	99.9	112.4	92.9	123.1	105.0
October	103.0	100.0	111.9	92.9	122.2	105.1
November	102.9	100.2	111.3	92.9	121.4	105.8
December	103.2	100.2	112.1	93.1	121.8	105.6

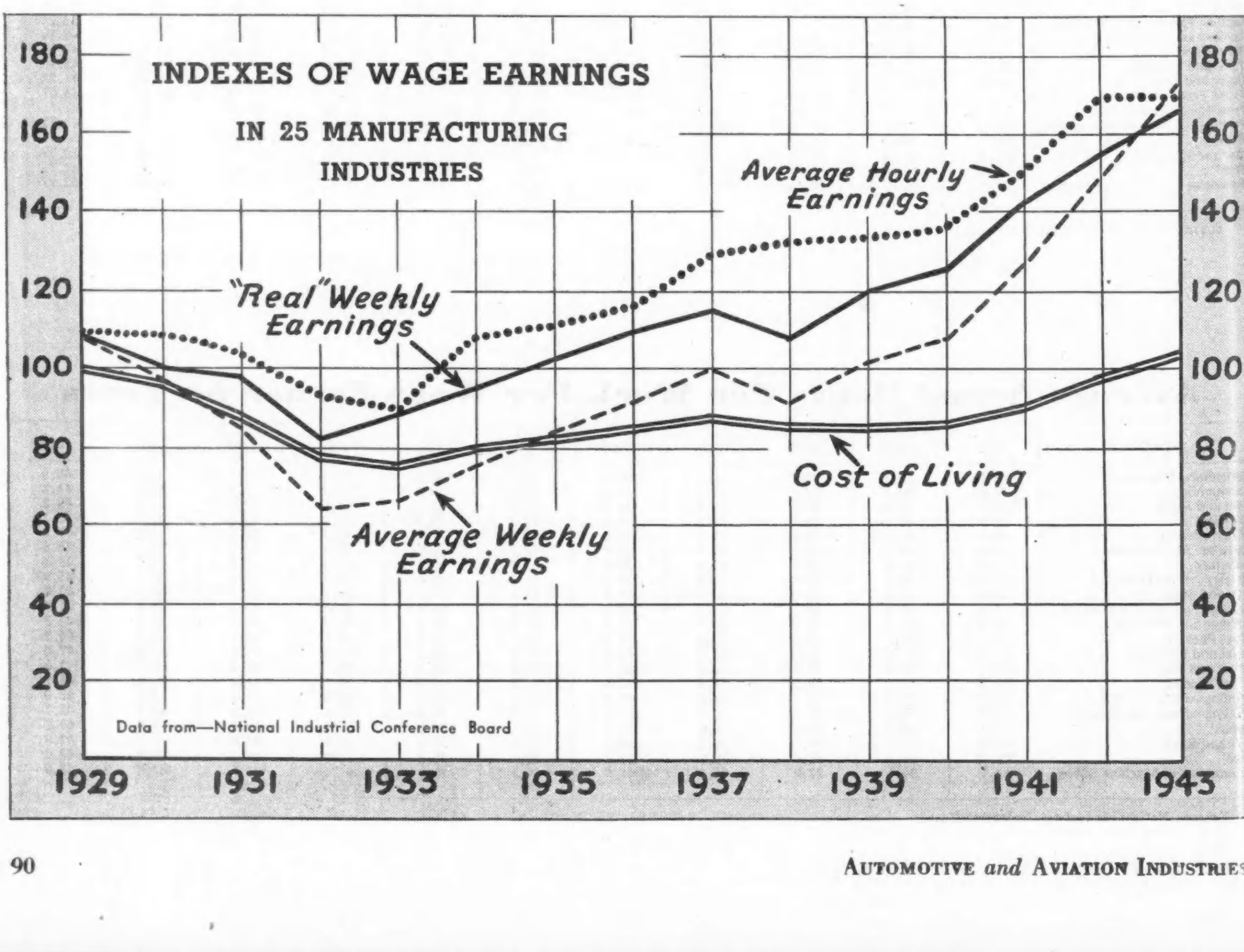
Source:—Bureau of Labor Statistics.

Cost of Living Index

Index, 1923 = 100

	Weighted Average All Items	Food	Housing	Clothing	Fuel and Light	Sundries
1929	100.1	106.9	92.0	98.7	93.4	99.7
1930	96.7	101.7	89.5	92.0	92.7	98.7
1931	87.2	83.7	82.4	79.5	90.5	96.6
1932	77.9	69.7	72.4	66.5	86.9	93.6
1933	74.9	67.8	63.8	67.6	85.2	91.4
1934	79.4	75.3	64.8	77.5	86.9	93.2
1935	82.2	80.8	70.3	75.0	85.7	93.8
1936	84.1	81.6	77.9	73.8	88.0	94.6
1937	87.8	84.7	86.5	76.9	85.2	96.9
1938	85.7	78.7	87.0	74.3	85.2	97.3
1939	84.5	76.6	86.3	72.3	84.9	98.8
1940	85.3	77.7	86.9	73.1	85.4	97.5
1941	89.0	85.3	88.5	75.3	87.9	99.4
1942	97.8	100.8	90.8	87.3	90.2	104.5
1943	103.3	112.6	90.8	89.3	92.7	107.4
1942						
January	94.5	95.2	90.1	82.4	90.3	102.5
February	95.3	95.7	90.4	84.5	90.3	103.5
March	96.2	97.4	90.7	85.8	90.3	103.7
April	97.1	98.6	91.0	88.4	89.7	103.9
May	97.3	99.0	91.1	88.6	90.0	104.3
June	97.4	99.5	91.1	88.1	90.2	104.3
July	97.8	100.1	90.8	88.0	90.5	104.7
August	98.1	101.1	90.8	88.2	89.5	104.8
September	98.8	102.8	90.8	88.4	90.5	104.6
October	99.8	105.3	90.8	88.5	90.5	105.3
November	100.5	106.4	90.8	88.6	90.6	106.2
December	101.1	108.2	90.8	88.6	90.6	106.2
1943						
January	101.5	108.8	90.8	88.6	92.1	106.4
February	101.9	110.0	90.8	88.6	92.3	106.5
March	103.0	112.8	90.8	88.6	92.4	106.5
April	104.0	115.4	90.8	88.6	92.5	106.5
May	104.2	115.8	90.8	88.5	92.6	106.7
June	104.3	115.8	90.8	88.6	92.5	107.1
July	103.1	112.4	90.8	88.9	92.5	107.2
August	102.8	111.4	90.8	89.3	92.6	107.3
September	103.1	112.0	90.8	89.8	92.6	107.4
October	103.7	112.6	90.8	90.6	92.7	108.6
November	103.7	112.1	90.8	90.9	93.1	109.1
December	103.9	111.9	90.8	91.1	94.9	110.1

Source:—National Industrial Conference Board.



Total U. S. Motor Vehicle Registrations by Years

Showing Increases and Decreases

Year	Passenger Cars	Trucks and Buses	Total Motor Vehicles	Per Cent Increase
1895	4	....	4	....
1896	16	....	16	....
1897	90	....	90	....
1898	800	....	800	....
1899	3,200	....	3,200	....
1900	8,000	....	8,000	....
1901	14,800	....	14,800	....
1902	23,000	....	23,000	....
1903	32,920	....	32,920	....
1904	54,590	410	55,000	....
1905	77,400	600	78,000	42
1906	105,900	1,100	107,000	37
1907	140,300	1,700	142,000	33
1908	194,400	3,100	197,500	39
1909	305,950	6,050	312,000	58
1910	458,500	10,000	468,500	50
1911	619,500	20,000	639,500	36
1912	902,600	41,400	944,000	48
1913	1,194,161	63,800	1,258,062	33
1914	1,625,739	85,600	1,711,339	36
1915	2,309,666	136,000	2,445,666	43
1916	2,297,996	215,000	3,512,996	44
1917	4,657,340	326,000	4,983,340	42
1918	5,621,617	525,000	6,146,617	23
1919	6,771,074	794,372	7,565,446	23
1920	8,225,859	1,006,082	9,231,941	22
1921	9,346,195	1,118,520	10,464,715	13
1922	10,864,128	1,375,725	12,239,853	17
1923	13,479,608	1,612,569	15,092,177	23
1924	15,460,649	2,134,724	17,595,373	17
1925	17,496,420	2,440,854	19,937,274	13
1926	19,237,171	2,764,222	22,001,393	10
1927	20,219,224	2,914,019	23,133,243	5
1928	21,379,125	3,113,999	24,493,124	6
1929	23,121,589	3,379,854	26,501,443	8
1930	23,183,241	3,473,831	26,657,072	0.2
1931*	22,567,381	3,426,515	25,993,896	−2.5
1932*	21,139,092	3,202,730	24,341,822	−6.4
1933*	20,557,493	3,292,439	23,849,932	−2.0
1934*	21,535,199	3,346,268	24,881,467	4.3
1935*	22,630,715	3,595,042	26,225,757	5.2
1936*	24,161,820	3,929,889	28,091,709	7.2
1937*	25,476,786	4,172,484	29,649,270	5.6
1938*	25,031,225	4,127,390	29,158,615	−1.7
1939*	25,854,022	4,440,206	30,294,228	+4.0
1940*	26,918,183	4,648,141	31,566,324	+4.1
1941*	28,842,622	4,878,315	33,720,937	+6.9
1942*	27,422,811	4,721,398	32,144,209	−4.7
1943*	25,451,007	4,508,360	29,959,367	−6.8

*—Automotive and Aviation Industries count, all others Bureau of Public Roads.

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Total Motor Vehicle Registrations by States—1943-1942

(As of the end of the Registration Year)

State	Passenger Cars 1943	Passenger Cars 1942	Trucks 1943	Trucks 1942	Busss 1943	Busss 1942	Total Motor Vehicles 1943	Total Motor Vehicles 1942	Per Cent Change	Per Cent of Total 1943	Per Cent of Total 1942
Alabama	288,530	299,731	65,606	66,026	1,464	1,351	355,600	367,108	− 3.2	1.19	1.14
Arizona	108,815	114,493	27,020	28,093	658	794(g)	136,493	143,380	− 4.9	.46	.45
Arkansas	194,716	213,081	71,916	75,267	883	(a)	267,495	288,348	− 7.3	.89	.90
California	2,302,384	2,378,731	327,304	344,566	(b)	(b)	2,629,588(c)	2,723,297	− 3.5	8.78	8.47
Colorado	277,117	331,476	68,887	31,784	1,430(d)	(a)	347,434	363,260	− 4.4	1.16	1.13
Connecticut	422,533	458,594	53,563	54,918	1,361	1,284	477,457	514,796	− 7.3	1.59	1.60
Delaware	54,636	55,765	13,576	13,416	(b)	(b)	68,212	69,181	−1.5	.23	.21
District of Columbia	119,734	143,810	15,037	14,646	2,292	2,319	137,063	160,775	−14.8	.46	.50
Florida	285,132	418,161	84,1[illegible]2	80,919	2,846	2,349	372,110	501,429	−25.8	1.24	1.56
Georgia	420,970	444,732	93,817	96,655	4,140	......	518,927	541,387	−4.2	1.73	1.68
Idaho	112,754	121,755	35,583	34,807	230	......	148,567	156,562	−5.2	.50	.49
Illinois	1,592,837	1,748,253	221,634	233,386	(b)	(b)	1,814,471	1,981,639	−9.5	6.06	6.16
Indiana	847,362	898,358	124,195	138,648	4,583	7,516	976,140	1,044,522	−6.6	3.26	3.25
Iowa	614,200	656,910	96,112	103,487	......	475	710,312	760,872	−6.7	2.37	2.37
Kansas	487,491	505,754	119,168	119,725	......	......	606,659	625,479	−3.1	2.02	1.95
Kentucky	364,000	384,294	74,000	77,412	......	1,177	438,000	462,883	−5.4	1.46	1.44
Louisiana	333,450	335,576	74,750	73,638	950	884	409,150	410,098	−0.3	1.36	1.27
Maine	145,280	157,630	41,959	42,074	481	440	187,720	200,144	−6.3	.63	.62
Maryland	394,304	430,679	58,639	60,627	1,480	1,530	454,423	492,836	−7.8	1.52	1.53
Massachusetts	718,563	804,566	104,253	109,783	4,262	5,489	827,078	919,838	−10.1	2.76	2.86
Michigan	1,171,353	1,195,406	98,663	131,153	(b)	(b)	1,270,016	1,326,559	−4.3	4.24	4.13
Minnesota	672,055	721,518	116,026	123,213	324	345	788,405	845,076	−6.8	2.63	2.63
Mississippi	187,792	184,453	60,900	61,744	711	2,139	249,403	248,336	+0.4	.83	.77
Missouri	716,619	794,846	148,608	159,342	......	......	865,227	954,188	−9.4	2.89	2.97
Montana	115,429	128,636	45,380	46,695	......	......	160,809	175,331	−8.3	.54	.55
Nebraska	334,967	346,515	71,726	70,328	703	287	407,396	417,130	−2.4	1.36	1.30
Nevada	40,000	40,225	9,300	10,037	......	144	49,300	50,406	−2.2	.16	.16
New Hampshire	84,478	96,716	27,195	32,569	(b)	(b)	111,673	129,285	−14.7	.37	.40
New Jersey	866,741	961,929	137,115	140,928	......	6,055	1,003,856	1,108,912	−9.5	3.35	3.45
New Mexico	86,635	86,073	28,645	28,559	750(e)	1,284	116,030	115,916	+0.1	.39	.36
New York	1,940,626	2,264,767	278,417	330,323	9,217	31,671(g)	2,228,260	2,626,761	−15.2	7.44	8.17
North Carolina	495,000	527,684	97,000	93,922	......	1,861	592,000	623,467	−5.1	1.98	1.94
North Dakota	134,959	142,104	44,397	41,935	116	147	179,472	184,186	−2.6	.60	.57
Ohio	1,744,603	1,866,276	181,865	193,325	2,933	3,141	1,929,401	2,062,742	−6.5	6.44	6.42
Oklahoma	406,505	440,911	101,969	109,586	1,892	1,756	510,366	552,253	−7.6	1.70	1.72
Oregon	332,552	341,367	74,724	75,217	1,136	982	408,412	417,566	−2.2	1.36	1.30
Pennsylvania	1,724,501	1,887,446	275,052	274,745	8,681	7,554	2,008,234	2,169,745	−7.5	6.70	6.75
Rhode Island	161,724	168,954	20,575	21,876	661	619	182,960	191,449	−4.5	.61	.60
South Carolina	283,091	295,211	49,257	48,341	2,323	1,748	334,671	345,300	−3.1	1.21	1.07
South Dakota	147,082	154,351	35,028	34,856	179	156	182,289	189,363	−3.8	.61	.59
Tennessee	354,000	388,028	68,000	74,285	......	3,750	422,000	466,063	−9.5	1.41	1.45
Texas	1,270,596	1,316,479	287,223	297,526	1,762	1,504	1,559,581	1,615,509	−3.5	5.20	5.03
Utah	132,004	128,440	25,549	24,905	686	609	158,239	153,954	+2.7	.53	.48
Vermont	71,305	77,748	10,207	9,858	147	139	81,659	87,745	−7.0	.27	.27
Virginia	424,127	449,837	80,878	83,048	2,743	1,496	507,748	534,381	−5.0	1.69	1.66
Washington	500,790	514,662	94,042	93,517	1,497	2,130	596,329	610,309	−2.3	1.99	1.90
West Virginia	209,527	245,669	47,124	49,321	955	1,016	257,606	296,006	−13.0	.86	.92
Wisconsin	694,493	687,499	136,371	143,087	1,603	947	832,467	831,533	+0.1	2.78	2.59
Wyoming	62,645	66,712	20,014	20,192	(a)	(a)	82,659	86,904	−4.9	.28	.27
Total	25,451,007	27,422,811	4,442,301	4,624,310	66,059	97,088	29,959,367	32,144,209	−6.8	100.00	100.00

(a)—Included with passenger cars.
(b)—Included with trucks.
(c)—Does not include 119,313 vehicles originally registered in other states for 1943 and 111,511 for 1942.
(d)—Under one ton only; all others with trucks.
(e)—School buses only, others with passenger cars.
(g)—Includes taxicabs.

Motor Vehicle Production by Years

Factory Sales and Wholesale Value, U. S. Plants

	PASSENGER CARS			MOTOR TRUCKS			TOTAL	
	Number	Wholesale Value	Average Wholesale Price	Number†	Wholesale Value†	Average Wholesale Price	Number	Wholesale Value
1904	22,130	$23,357,692	$1055	700	$1,272,747	$1818	22,830	$24,630,439
1905	24,250	38,670,000	1594	750	1,330,000	1773	25,000	40,000,000
1906	33,200	61,460,000	1851	800	1,440,000	1800	34,000	62,900,000
1907	43,000	91,620,000	2131	1,000	1,780,000	1780	44,000	93,400,000
1908	63,500	135,250,000	2129	1,500	2,550,000	1700	65,000	137,800,000
1909	123,990	159,765,721	1288	3,297	5,333,683	1617	127,287	165,099,404
1910	181,000	215,340,000	1189	6,000	9,660,000	1610	187,000	225,000,000
1911	199,319	225,000,000	1128	10,681	21,000,000	1966	210,000	246,000,000
1912	356,000	335,000,000	941	22,000	43,000,000	1954	378,000	378,000,000
1913	461,500	399,902,000	866	23,500	44,000,000	1872	485,000	443,902,000
1914	548,139	420,838,378	768	24,900	44,219,096	1775	573,039	465,057,474
1915	895,930	575,978,000	643	74,000	125,800,000	1700	969,930	701,778,000
1916	1,525,578	921,378,000	604	92,130	161,000,000	1747	1,617,708	1,082,378,000
1917	1,745,792	1,053,505,781	603	128,157	220,982,668	1724	1,873,949	1,274,488,449
1918	943,436	801,937,925	850	227,250	434,168,992	1910	1,170,686	1,236,106,917
1919	1,651,625	1,365,395,415	827	224,731	371,422,820	1652	1,876,356	1,736,818,235
1920	1,905,560	1,809,170,963	949	321,789	423,249,410	1315	2,227,349	2,232,420,373
1921	1,468,067	1,038,191,037	707	148,052	166,070,810	1122	1,616,119	1,204,261,847
1922	2,274,185	1,494,513,991	657	269,991	226,049,658	837	2,544,176	1,720,563,649
1923	3,624,717	2,196,272,116	606	409,295	308,537,929	754	4,034,012	2,504,810,045
1924	3,185,881	1,970,096,559	618	416,659	318,580,580	765	3,602,540	2,288,677,139
1925	3,735,171	2,458,370,026	658	530,659	458,400,277	864	4,265,830	2,916,770,303
1926	3,783,987	2,640,064,519	698	316,947	452,123,435	875	4,300,934	3,092,187,954
1927	2,936,533	2,164,670,891	737	464,793	420,130,624	904	3,401,326	2,584,801,515
1928	3,815,417	2,576,489,623	675	543,342	437,132,258	804	4,358,759	3,013,621,881
1929	4,587,400	2,847,118,562	621	771,020	566,029,644	734	5,358,420	3,413,148,206
1930	2,784,745	1,645,398,523	591	571,241	389,436,690	682	3,355,986	2,034,835,213
1931	1,973,090	1,111,273,774	563	416,648	262,417,542	630	2,389,738	1,373,691,316
1932	1,135,491	618,291,168	544	235,187	136,193,336	579	1,370,678	754,484,504
1933	1,573,512	762,736,512	485	346,545	186,069,314	537	1,920,057	948,805,826
1934	2,177,919	1,147,116,195	527	575,192	320,143,667	556	2,753,111	1,467,259,862
1935	3,252,244	1,709,425,904	526	694,690	379,407,751	546	3,946,934	2,088,833,655
1936	3,669,528	2,015,646,217	549	784,587	462,820,474	590	4,454,115	2,478,466,691
1937*	3,915,889	2,304,349,252	588	893,085	542,921,096	608	4,808,974	2,847,270,348
1938*	2,000,985	1,269,765,050	634	488,100	339,226,639	695	2,489,085	1,608,991,689
1939*	2,866,796	1,816,434,914	634	710,496	502,421,776	707	3,577,292	2,318,856,690
1940*	3,692,328	2,422,491,461	656	777,026	593,731,603	764	4,469,354	3,016,223,064
1941*	3,744,300	2,615,697,373	698	1,094,261	1,086,925,650	993	4,838,561	3,702,623,023

*—Includes Federal excise taxes and standard equipment.
†—A substantial part of the trucks reported comprise chassis only; hence the value of bodies for these chassis is not included.

Production of Trucks and Truck Tractors*

1940	Light	Medium	Heavy	Total
January	32,976	23,775	11,484	68,235
February	30,838	22,427	10,289	63,554
March	32,204	24,816	11,839	68,859
April	32,498	24,296	10,109	66,903
May	30,731	21,819	9,143	61,693
June	27,292	21,036	9,400	57,728
July	26,427	24,202	10,679	61,308
August	8,780	11,213	6,038	26,031
September	20,545	13,082	9,563	43,190
October	36,919	25,046	12,243	74,208
November	36,691	28,712	11,684	77,087
December	38,249	31,355	11,940	81,544
Total	354,150	271,779	124,411	750,340
1941				
January	43,555	31,128	12,947	87,630
February	42,423	31,242	15,020	88,685
March	45,427	32,437	15,176	93,040
April	38,622	32,212	10,652	81,486
May	45,334	35,049	19,231	99,614
June	42,399	36,573	17,827	96,799
July	41,527	40,843	14,330	96,700
August	25,576	28,909	10,380	64,865
September	23,528	30,878	5,031	59,437
October	30,953	35,974	18,735	85,662
November	34,398	40,931	18,965	94,294
December	25,889	48,039	20,130	94,058
Total	439,631	424,215	178,424	1,042,270

1942	Light	Medium	Heavy	Total
January	27,546	49,573	15,161	92,280
February	15,460	43,224	17,757	76,441
March	22,020	46,774	19,814	88,608
April	23,035	20,820	19,427	63,282
May	22,743	13,352	24,031	60,126
June	28,108	21,589	23,160	72,857
July	30,141	11,729	21,136	63,006
August	28,088	10,220	20,955	59,263
September	26,980	11,649	20,671	59,300
October	26,661	8,720	20,986	56,367
November	24,413	8,503	18,293	51,209
December	25,645	9,114	19,697	54,456
Total	300,840	255,267	241,088	797,195
1943				
January	23,729	7,017	19,171	49,917
February	23,314	6,453	18,048	47,815
March	27,544	8,268	20,620	56,432
April	23,107	9,717	23,273	56,097
May	21,217	12,696	21,229	55,142
June	20,734	14,070	21,658	56,462
July	20,925	16,024	23,321	60,270
August	19,944	17,809	23,520	61,273
September	21,089	16,094	20,254	57,437
Total, 9 Mos.	201,603	108,148	191,094	500,845

These data cover actual production of trucks in the United States for military and civilian use. Jeeps, military ambulances and wheel-drive personnel carriers are included, but not half-tracks or armored cars. Light trucks are those up to 9,000 lb. gross vehicle weight; medium 9,000 to 16,000 lb.; and heavy 16,000 lb. and over gross vehicle weight. For 1940 and 1941 the classifications were: light up to 1½ tons, medium 1½ to 2½ tons and heavy 2½ tons carrying capacity and over.

* Automotive Division, War Production Board.

★ ★ New Motor Vehicle Registrations ★

Comparative Record of Retail Sales—Cars and Trucks

	New Passenger Cars	New Trucks	Total New Cars and Trucks
1926	3,228,401	385,997	3,614,398
1927	2,623,538	327,965	2,951,503
1928	3,139,579	341,123	3,480,702
1929	3,880,206	527,057	4,407,263
1930	2,625,979	410,699	3,036,678
1931	1,908,141	313,884	2,222,025
1932	1,096,399	180,413	1,276,812
1933	1,493,794	245,869	1,739,663
1934	1,888,557	403,886	2,292,443
1935	2,743,908	510,683	3,254,591
1936	3,404,497	611,644	4,016,141
1937	3,483,752	618,249	4,102,001
1938	1,891,021	365,349	2,256,370
1939	2,653,377	486,748	3,140,125
1940	3,415,905	576,327	3,992,232
1941	3,731,166	640,697	4,371,863
1942†	113,275	41,944	155,219

†—3 Months only. *—R. L. Polk & Co.

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Number of Automotive Wholesalers, Dealers and Independent Repair Shops—By States 1942-1944

(As of February of Each Year)

	Wholesalers			Car and Truck Dealers			Independent Repair Shops			All Retail Outlets †		
	1942	1944	Numerical Change	1942	1944	Numerical Change	1942	1944	Numerical Change	1942	1944	Numerical Change
Alabama	83	87	+ 4	430	393	−37	304	302	− 2	819	748	−71
Arizona	33	33	....	157	119	−38	144	136	− 8	330	263	−67
Arkansas	80	81	+ 1	381	336	−45	306	273	−33	703	636	−67
California	535	510	−25	1,966	1,512	−454	4,921	4,111	−810	7,510	5,908	−1,602
Colorado	74	66	− 8	479	340	−139	543	454	−89	1,091	851	−240
Connecticut	104	95	− 9	580	522	−58	692	647	−45	1,462	1,325	−137
Delaware	14	13	− 1	75	64	−11	73	64	− 9	173	151	−22
District of Columbia	24	23	− 1	87	72	−15	153	122	−31	260	215	−45
Florida	117	105	−12	503	384	−119	563	464	−99	1,170	894	−276
Georgia	104	96	− 8	599	497	−102	374	335	−39	1,028	803	−225
Idaho	34	34	....	335	256	−79	219	202	−17	578	491	−87
Illinois	416	381	−35	2,381	1,991	−390	2,852	2,667	−185	5,579	4,835	−684
Indiana	210	187	−23	1,205	1,046	−159	1,147	1,046	−101	2,366	2,096	−270
Iowa	174	162	−12	1,459	1,111	−348	1,185	1,058	−127	2,835	2,235	−600
Kansas	135	120	−15	977	743	−234	810	661	−149	1,769	1,416	−353
Kentucky	105	92	−13	618	562	−56	422	374	−48	1,106	953	−153
Louisiana	75	70	− 5	409	353	−56	369	349	−20	816	708	−108
Maine	48	43	− 5	364	327	−37	410	384	−26	750	699	−51
Maryland	83	70	−13	471	411	−60	446	373	−73	950	813	−137
Massachusetts	223	195	−28	1,099	956	−143	1,154	1,041	−113	2,493	2,240	−253
Michigan	255	240	−15	1,840	1,580	−260	1,823	1,820	− 3	4,035	3,551	−484
Minnesota	128	131	+ 3	1,412	960	−452	1,647	1,555	−92	3,245	2,590	−655
Mississippi	76	66	−10	420	360	−60	199	170	−29	622	564	−58
Missouri	218	193	−25	1,041	897	−144	1,336	1,240	−96	2,512	2,201	−311
Montana	49	44	− 5	401	304	−97	563	225	−338	658	566	−92
Nebraska	96	74	−22	692	543	−149	720	597	−123	1,491	1,179	−312
Nevada	10	10	....	88	71	−17	94	81	−13	196	170	−26
New Hampshire	26	24	− 2	229	191	−38	250	200	−50	488	408	−80
New Jersey	191	165	−26	1,099	871	−228	1,751	1,477	−274	2,983	2,513	−470
New Mexico	36	30	− 6	180	134	−46	140	117	−23	338	265	−73
New York	521	453	−68	2,909	2,362	−547	5,078	4,418	−660	8,481	6,969	−1,512
North Carolina	132	133	+ 1	766	644	−122	485	471	−14	1,331	1,193	−138
North Dakota	24	29	+ 5	495	379	−116	468	391	−77	1,001	827	−174
Ohio	383	343	−40	2,282	1,689	−593	2,300	1,998	−302	4,809	3,964	−845
Oklahoma	138	125	−14	713	614	−99	805	694	−111	1,690	1,371	−319
Oregon	88	92	+ 4	474	365	−109	863	670	−193	1,427	1,073	−354
Pennsylvania	442	415	−27	3,182	2,708	−474	3,724	3,620	−104	7,349	6,818	−531
Rhode Island	29	28	− 1	167	130	−37	206	171	−35	402	333	−69
South Carolina	58	56	− 2	404	329	−75	245	221	−24	608	538	−70
South Dakota	32	30	− 2	411	325	−86	326	278	−48	756	638	−118
Tennessee	111	97	−14	496	418	−78	401	377	−24	935	825	−110
Texas	372	340	−32	1,985	1,664	−321	2,684	2,298	−386	4,816	4,107	−709
Utah	44	41	− 3	208	174	−34	242	210	−32	485	428	−57
Vermont	28	21	− 7	209	178	−31	282	241	−41	507	434	−73
Virginia	86	86	....	707	630	−77	645	643	−2	1,449	1,339	−110
Washington	141	136	− 5	769	559	−210	1,295	994	−301	2,146	1,609	−537
West Virginia	79	68	−11	504	420	−84	345	300	−45	889	761	−128
Wisconsin	142	143	+ 1	1,678	1,333	−345	1,416	1,248	−168	3,222	2,674	−548
Wyoming	25	25	....	201	173	−28	132	115	−17	363	302	−61
Total	6,631	6,101	−530	40,537	33,000	−7,537	47,552	41,903	−5,649	93,022	78,550	−14,472
Percentage Change	......	......	−8.0%	......	......	−18.5%	......	......	12.0%	......	......	−15.6%

Trade List Department—Chilton Company. †—Duplications eliminated. Includes, in addition to items shown, all exclusive accessory establishments and exclusive body and wreckers shops.

Number of Passenger Cars Released

State	January 1943	February 1943	March 1943	March 1942	April 1943	April 1942	May 1943	May 1942	June 1943	June 1942	July 1943	July 1942
Alabama	158	206	625	220	620	399	513	471	403	401	328	349
Arizona	79	66	186	35	146	65	156	107	118	141	106	116
Arkansas	135	206	406	118	475	129	338	194	273	169	219	213
California	1,335	1,058	2,450	652	2,982	1,025	3,578	1,773	3,010	1,688	2,778	1,913
Colorado	120	132	245	113	265	114	142	219	210	181	191	251
Connecticut	131	105	308	347	333	459	309	418	181	290	191	275
Delaware	27	24	43	33	103	76	83	50	45	51	57	39
District of Columbia	86	61	201	154	113	174	165	207	119	165	108	185
Florida	216	236	589	141	590	276	549	283	403	256	388	272
Georgia	295	252	683	344	731	529	667	555	544	313	553	392
Idaho	52	56	185	64	119	59	98	89	92	76	63	81
Illinois	593	760	1,671	763	1,757	1,285	1,691	1,838	1,584	1,494	1,466	1,634
Indiana	296	365	828	718	855	1,000	745	1,050	626	914	520	972
Iowa	212	204	643	209	558	337	529	583	485	574	334	520
Kansas	197	251	500	175	633	246	513	222	420	214	294	365
Kentucky	156	130	288	328	410	358	396	412	325	265	288	302
Louisiana	176	249	461	237	614	340	543	385	501	314	419	363
Maine	42	53	134	90	165	71	161	102	108	94	138	137
Maryland	207	144	471	285	439	489	398	566	267	389	295	437
Massachusetts	197	236	754	321	799	365	799	480	452	363	538	530
Michigan	553	629	1,237	1,243	1,735	3,401	1,817	4,655	1,468	2,299	1,316	2,601
Minnesota	196	222	572	241	768	639	635	825	556	552	452	516
Mississippi	112	179	362	155	382	149	364	236	312	254	224	195
Missouri	242	278	798	363	874	537	670	686	558	465	539	591
Montana	57	48	162	53	175	63	142	126	124	88	88	113
Nebraska	147	168	395	108	395	264	343	283	260	268	195	256
Nevada	33	37	78	48	90	36	80	70	75	68	57	66
New Hampshire	15	18	78	50	90	34	60	39	46	37	51	45
New Jersey	223	221	583	665	644	553	684	699	468	490	551	370
New Mexico	40	59	136	45	123	39	105	56	99	54	83	66
New York	382	419	1,572	1,107	1,690	1,725	1,681	1,678	1,115	1,281	1,217	1,337
North Carolina	190	192	736	192	716	239	657	468	570	424	520	422
North Dakota	48	43	122	32	177	78	193	83	185	73	188	77
Ohio	648	734	1,804	1,258	1,877	2,423	1,779	2,380	1,448	2,038	1,398	2,187
Oklahoma	235	255	628	151	685	205	540	263	423	284	397	384
Oregon	187	222	464	141	452	161	343	339	269	394	208	394
Pennsylvania	334	525	1,347	1,207	1,476	1,339	1,446	1,693	1,041	1,560	1,155	1,701
Rhode Island	39	52	138	113	144	75	92	85	85	78	119	101
South Carolina	122	180	469	168	464	281	449	296	337	213	307	173
South Dakota	57	38	133	33	182	61	141	90	149	116	139	74
Tennessee	171	198	638	273	546	540	542	338	486	438	359	371
Texas	991	1,000	2,394	787	2,590	1,226	2,120	1,743	1,605	1,354	1,637	1,339
Utah	114	92	290	112	198	105	177	125	159	164	143	178
Vermont	15	24	43	42	70	31	49	44	38	38	45	31
Virginia	165	142	573	270	597	398	559	466	434	365	391	425
Washington	291	220	555	192	503	291	475	410	452	455	381	647
West Virginia	65	84	175	121	200	286	190	286	189	187	183	208
Wisconsin	153	215	536	377	609	539	662	680	593	579	468	619
Wyoming	35	35	76	30	89	27	81	78	59	52	52	64
Federal Authorizations	740	400	240	461	98	797	98	1,012	314	392	473	697
Bus Conversions	18	39	43	0	0	0	46	0	1	0	10	0
Total	11,328	11,762	29,048	15,390	31,346	24,338	29,593	30,236	24,084	23,412	22,620	25,594

Office of Price Administration, Automotive Supply Rationing Division.
Data covers releases in the Continental United States only.
This table excludes 28,748 passenger cars sold on or before January 1, 1942 but delivered after that date.
1943 data includes all new and used 1942 cars.

RATIONING ★ ★ ★ ★

By Months, By States, 1943-1942

August 1943	August 1942	September 1943	September 1942	October 1943	October 1942	November 1943	November 1942	December 1943	December 1942	Total 1943	Total 1942	State
328	395	267	306	283	166	239	105	192	88	4,162	2,900	Alabama
79	117	63	87	67	65	51	31	46	32	1,163	796	Arizona
207	275	155	177	163	138	146	94	155	105	2,878	1,612	Arkansas
2,193	2,157	1,852	1,626	1,883	1,260	1,681	864	1,263	718	26,063	13,676	California
163	330	116	185	159	141	118	78	104	96	1,965	1,708	Colorado
309	337	266	236	245	200	220	158	138	140	2,736	2,860	Connecticut
59	41	70	43	55	34	38	24	32	50	636	441	Delaware
124	187	156	80	87	73	70	74	64	50	1,354	1,349	District of Columbia
359	245	317	244	341	186	294	118	193	151	4,475	2,172	Florida
506	471	485	420	461	326	399	190	308	210	5,884	3,750	Georgia
52	138	54	91	60	73	54	40	29	27	914	738	Idaho
1,276	1,842	992	1,238	828	801	751	528	631	471	14,000	11,894	Illinois
477	939	377	557	379	361	312	292	246	202	6,026	7,005	Indiana
316	543	221	363	191	226	198	156	157	143	4,048	3,654	Iowa
271	354	239	398	239	225	231	151	183	121	3,971	2,471	Kansas
252	282	153	295	142	165	156	93	178	105	2,874	2,605	Kentucky
383	326	354	232	396	217	301	163	179	130	4,576	2,707	Louisiana
121	119	122	86	96	67	121	57	133	52	1,394	875	Maine
359	487	300	348	295	320	255	277	169	152	3,599	3,750	Maryland
716	468	642	357	606	295	534	248	350	219	6,623	3,646	Massachusetts
1,171	2,150	815	1,210	716	773	678	619	504	484	12,639	19,435	Michigan
348	553	247	396	196	301	192	163	185	159	4,569	4,345	Minnesota
214	282	198	146	200	149	130	88	141	77	2,818	1,731	Mississippi
446	776	339	460	309	297	273	193	252	172	5,578	4,540	Missouri
70	137	47	102	56	92	29	53	33	49	1,031	876	Montana
153	338	131	232	140	159	140	84	108	85	2,575	2,077	Nebraska
55	83	48	100	41	34	34	18	28	25	656	548	Nevada
68	53	71	46	53	42	38	32	37	14	625	392	New Hampshire
676	484	704	392	550	417	513	273	358	275	6,172	4,618	New Jersey
76	65	96	44	66	49	72	32	54	30	1,009	480	New Mexico
1,537	1,262	1,444	747	1,216	699	1,031	677	688	431	13,992	10,944	New York
518	517	517	441	448	369	335	312	264	235	5,663	3,619	North Carolina
115	82	94	68	106	66	87	45	76	29	1,434	633	North Dakota
1,147	2,281	950	1,285	748	967	662	663	556	531	13,751	16,013	Ohio
325	393	261	326	276	208	246	168	219	166	4,490	2,548	Oklahoma
153	423	144	338	153	227	152	123	128	111	2,875	2,651	Oregon
1,239	1,547	1,183	980	933	794	799	524	633	470	12,111	11,815	Pennsylvania
129	88	120	75	96	70	73	45	58	42	1,145	772	Rhode Island
313	238	281	254	254	198	203	162	171	137	3,550	2,120	South Carolina
96	87	66	94	65	51	59	45	49	44	1,174	695	South Dakota
383	472	316	341	302	227	241	155	198	126	4,380	3,286	Tennessee
1,661	1,599	1,383	1,379	1,544	929	1,259	592	979	806	19,163	11,754	Texas
156	181	140	169	110	108	96	79	77	55	1,752	1,276	Utah
33	42	44	37	34	24	24	24	13	14	432	327	Vermont
447	557	413	442	295	334	319	227	237	177	4,572	3,661	Virginia
348	805	407	456	276	288	269	225	216	169	4,393	3,938	Washington
163	208	121	146	118	102	78	204	72	45	1,638	1,793	West Virginia
377	639	262	409	293	285	196	34	201	214	4,565	4,375	Wisconsin
52	102	44	68	52	47	23	75	29	19	627	562	Wyoming
355	1,398	333	512	303	459	215	259	123	25,909	3,692	31,896	Federal Authorizations
0	5	0	0	2	16	0	39	0	9	159	69	Bus Conversions
21,371	27,900	18,420	19,064	16,927	14,120	14,635	9,973	11,314	34,371	242,571	224,398	Total

Office of Price Administration, Automotive Supply Rationing Division.
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1943 data includes all new and used 1942 cars.

FEDERAL AND STATE

1943 Motor Vehicle Taxes Drop 20% From 1942

Federal Automotive Taxes—by Source*

Source of Revenue	1943	1942	1941	1940	1939
Lubricating Oil †	$49,210,861	$41,176,446	$43,851,860	$34,420,051	$29,836,487
Gasoline †	265,303,272	336,684,644	371,135,781	281,653,761	215,217,325
Tires and Tubes	31,947,997	25,356,782	71,858,420	45,091,092	41,167,734
Trucks	1,798,380	13,329,541	14,253,274	9,285,246	7,144,898
Automobiles and Motorcycles	1,130,456	26,933,596	101,463,603	71,275,162	51,063,559
Parts and Accessories	25,063,618	26,120,836	18,561,870	12,147,151	8,956,584
Use of Motor Vehicles	134,619,279	210,158,464	....	....	....
TOTAL—FEDERAL TAXES	$509,073,863	$679,860,309	$621,124,808	$453,872,463	$353,386,587

State Automotive Taxes

(Exclusive of State or Local Sales Tax and Special Carrier Taxes)

	1943	1942	1941	1940	1939
Gasoline	$653,580,000	$839,457,000	$950,956,000	$864,472,000	$816,433,000
Registration Fees	409,729,000	448,968,000	490,666,000	438,010,000	412,494,000
TOTAL—STATE TAXES	$1,063,309,000	$1,288,425,000	$1,440,622,000	$1,302,482,000	$1,228,927,000
TOTAL—FEDERAL AND STATE TAXES	$1,572,382,863	$1,968,285,309	$2,061,746,808	$1,756,354,463	$1,582,313,587

*—Internal Revenue collections for calendar years.
†—Automotive share of total collections shown here approximately 52% for lubricating oil and 89% for gasoline.

Federal Tax Rates on Automotive Products

(From 1940 through 1943)

LUBRICATING OILS

4 cents per gallon to July 1, 1940
4½ cents per gallon to Nov. 1, 1942
6 cents per gallon thereafter

GASOLINE

1 cent per gallon to July 1, 1940
1½ cents per gallon thereafter

TIRES

2¼ cents per pound to July 1, 1940
2½ cents per pound to Oct. 1, 1941
5 cents per pound thereafter

TUBES

4 cents per pound to July 1, 1940
4½ cents per pound to Oct. 1, 1941
9 cents per pound thereafter

TRUCKS

2% of manufacturers' sales price to July 1, 1940
2½% of manufacturers' sales price to Oct. 1, 1941
5% of manufacturers' sales price thereafter

PASSENGER CARS & MOTORCYCLES

3% of manufacturers' sales price to July 1, 1940
3½% of manufacturers' sales price to Oct. 1, 1940
7% of manufacturers' sales price thereafter

PARTS AND ACCESSORIES

2% of manufacturers' sales price to July 1, 1940
2½% of manufacturers' sales price to Oct. 1, 1941
5% of manufacturers' sales price thereafter

USE OF MOTOR VEHICLES

$5.00 per vehicle per fiscal year

State Automotive Taxes, 1928–1942

(Exclusive of State or Local Sales Tax and Special Carrier Taxes)

	Gasoline Tax	Registration Fees
1928	$304,872,000	$322,630,000
1929	431,312,000	347,844,000
1930	493,865,000	355,705,000
1931	536,397,000	344,338,000
1932	513,047,000	324,274,000
1933	518,196,000	302,716,000
1934	565,027,000	307,260,000
1935	616,852,000	322,954,000
1936	686,631,000	359,783,000
1937	756,930,000	399,613,000
1938	766,853,000	388,825,000
1939	816,433,000	412,494,000
1940	864,472,000	439,178,000
1941	950,956,000	490,666,000
1942	839,457,000	448,968,000
1943	653,580,000	409,729,000

Federal Motor Vehicle Use Tax Receipts

1942		1943	
January	$17,351,612	January	$264,413
February	39,371,107	February	132,844
March	4,608,245	March	80,980
April	762,165	April	83,361
May	379,116	May	68,991
June	10,152,626	June	8,125,103
July	119,502,401	July	104,291,674
August	13,262,733	August	17,002,427
September	2,283,172	September	2,590,581
October	936,877	October	1,079,797
November	851,066	November	633,085
December	697,343	December	266,023
Total	$210,158,463	Total	$134,619,279

AUTOMOTIVE TAXES ★ ★

State Gasoline Tax Receipts and Registration Fees—1943-1942

(Exclusive of State or Local Sales Tax or Special Carrier Tax)

STATE	State Tax—Cents per Gallon	State Gasoline Tax Receipts 1943	State Gasoline Tax Receipts 1942	State Gasoline Tax Receipts Per Cent Change	State Registration Fees 1943	State Registration Fees 1942	State Registration Fees Per Cent Change	Total State Tax Receipts from Gasoline and Registration Fees 1943	Total State Tax Receipts from Gasoline and Registration Fees 1942	State Taxes per Motor Vehicle 1943	State Taxes per Motor Vehicle 1942
Alabama	6	$14,318,000	$18,360,000	−22.1	$5,600,000	$5,716,000	− 2.1	$19,918,000	$24,076,000	$56.01	$65.58
Arizona	5	4,500,000	5,260,000	−14.5	1,400,000	1,320,000	+ 6.0	5,900,000	6,580,000	43.22	45.89
Arkansas	6½	10,230,000	12,658,000	−19.2	4,241,000	4,135,000	+ 2.5	14,471,000	16,793,000	54.09	58.23
California	3	50,000,000	53,912,000	− 7.3	28,600,000	29,397,000	− 2.8	78,600,000	83,309,000	29.89	30.59
Colorado	4	6,305,000	8,168,000	−22.9	2,417,000	2,999,000	−19.5	8,722,000	11,167,000	25.10	30.74
Connecticut	3	7,389,000	9,343,000	−21.0	7,107,000	7,916,000	−10.3	14,496,000	17,259,000	30.36	33.52
Delaware	4	1,633,000	2,028,000	−19.5	1,143,000	1,259,000	− 9.3	2,776,000	3,287,000	40.69	47.51
District of Columbia	3	3,247,000	4,230,000	−23.3	1,247,000	1,759,000	−29.2	4,494,000	5,989,000	32.78	37.25
Florida	7	20,593,000	23,402,000	−12.1	9,052,000	10,451,000	−13.4	29,645,000	33,853,000	79.66	67.51
Georgia	6	18,182,000	21,585,000	−15.8	2,227,000	2,900,000	−23.3	20,409,000	24,485,000	39.32	45.22
Idaho	5.1	3,900,000	4,721,000	−17.4	1,344,000	1,339,000	+ 0.3	5,244,000	6,060,000	35.29	38.70
Illinois	3	29,112,000	39,734,000	−26.8	23,668,000	26,834,000	−11.8	52,780,000	66,568,000	29.08	33.59
Indiana	4	19,756,000	25,897,000	−23.8	9,688,000	10,946,000	−11.5	29,444,000	36,843,000	30.16	35.27
Iowa	3	10,696,000	13,777,000	−22.4	12,314,000	13,364,000	− 7.9	23,010,000	27,141,000	32.39	35.67
Kansas	3	8,863,000	10,216,000	−13.3	4,292,000	4,445,000	− 3.5	13,155,000	14,661,000	21.68	23.43
Kentucky	5	12,196,000	14,284,000	−14.7	4,200,000	4,688,000	−10.5	16,396,000	18,972,000	37.43	40.98
Louisiana	7	16,258,000	19,552,000	−16.9	3,200,000	3,356,000	− 4.7	19,458,000	22,908,000	47.55	55.85
Maine	4	3,891,000	5,119,000	−24.0	3,839,000	4,086,000	− 6.1	7,730,000	9,205,000	41.17	45.99
Maryland	4	9,057,000	11,313,000	−20.0	5,575,000	6,300,000	−11.6	14,632,000	17,613,000	32.19	35.73
Massachusetts	3	13,068,000	16,627,000	−21.5	6,887,000	7,293,000	− 5.6	19,955,000	23,920,000	24.12	26.00
Michigan	3	23,089,000	31,615,000	−27.0	23,393,000	24,798,000	− 5.7	46,482,000	56,413,000	36.59	42.52
Minnesota	4	13,390,000	18,846,000	−29.0	8,171,000	9,814,000	−16.8	21,561,000	28,660,000	27.34	33.91
Mississippi	6	9,994,000	12,650,000	−21.0	1,252,000	3,012,000	−58.5	11,246,000	15,662,000	45.09	63.06
Missouri	2	8,890,000	12,670,000	−29.9	10,048,000	10,922,000	− 8.1	18,938,000	23,592,000	21.88	24.72
Montana	5	3,644,000	4,749,000	−23.3	1,300,000	1,550,000	−16.2	4,944,000	6,299,000	30.74	35.92
Nebraska	5	9,500,000	11,661,000	−19.6	2,891,000	2,897,000	− 0.3	12,391,000	14,558,000	30.41	34.90
Nevada	4	1,086,000	1,671,000	−35.1	375,000	394,000	− 4.9	1,461,000	2,065,000	29.63	40.96
New Hampshire	4	1,950,000	2,891,000	−32.6	2,598,000	2,920,000	−11.1	4,548,000	5,811,000	40.72	44.94
New Jersey	3	15,094,000	21,631,000	−30.3	19,298,000	22,466,000	−14.2	34,392,000	44,097,000	34.25	39.76
New Mexico	5	3,351,000	4,362,000	−23.2	1,561,000	1,940,000	−19.6	4,912,000	6,302,000	42.33	54.37
New York	4	42,926,000	58,657,000	−26.9	47,016,000	49,073,000	− 4.2	89,942,000	107,730,000	39.47	41.01
North Carolina	6	20,371,000	24,293,000	−16.2	10,426,000	9,329,000	+11.7	30,797,000	33,622,000	52.02	53.92
North Dakota	4	2,427,000	3,226,000	−24.8	1,771,000	1,944,000	− 8.9	4,198,000	5,170,000	23.39	28.06
Ohio	4	30,569,000	52,911,000	−42.3	28,779,000	31,640,000	− 9.1	59,348,000	84,551,000	30.75	40.98
Oklahoma	5½	15,221,000	19,142,000	−20.5	8,008,000	8,839,000	− 9.5	23,229,000	27,981,000	45.51	50.66
Oregon	5	9,738,000	11,934,000	−18.5	3,674,000	3,753,000	− 2.2	13,412,000	15,687,000	32.83	37.56
Pennsylvania	4	42,872,000	55,883,000	−23.3	32,191,000	37,952,000	−15.2	75,063,000	93,835,000	37.37	43.24
Rhode Island	3	2,553,000	3,404,000	−25.0	2,750,000	3,256,000	−15.6	5,303,000	6,660,000	28.98	34.78
South Carolina	6	10,502,000	13,053,000	−19.6	2,223,000	2,195,000	+ 1.2	12,725,000	15,248,000	38.02	44.15
South Dakota	4	3,609,000	4,378,000	−17.6	1,529,000	1,753,000	−12.8	5,138,000	6,131,000	28.18	32.37
Tennessee	7	19,847,000	23,509,000	−15.6	5,500,000	6,007,000	− 8.5	25,347,000	29,516,000	60.06	63.33
Texas	4	38,567,000	48,365,000	−20.3	22,916,000	26,167,000	−12.5	61,483,000	74,532,000	39.42	46.13
Utah	4	3,893,000	4,249,000	− 8.4	1,369,000	1,317,000	+ 3.9	5,262,000	5,566,000	33.25	36.15
Vermont	4	1,599,000	2,256,000	−29.2	2,214,000	2,491,000	−11.2	3,813,000	4,747,000	46.69	54.09
Virginia	5	15,216,000	19,472,000	−21.9	7,561,000	8,256,000	− 8.5	22,777,000	27,728,000	44.85	51.88
Washington	5	16,300,000	18,327,000	−11.1	3,394,000	4,138,000	−18.0	19,694,000	22,465,000	33.02	36.80
West Virginia	5	7,200,000	9,996,000	−28.0	5,236,000	5,806,000	− 9.9	12,436,000	15,802,000	48.27	53.38
Wisconsin	4	15,034,000	20,991,000	−28.4	13,616,000	13,199,000	+ 3.1	28,650,000	34,190,000	34.41	41.11
Wyoming	4	1,954,000	2,479,000	−21.2	628,000	637,000	− 1.5	2,582,000	3,116,000	31.23	35.85
Total		$653,580,000	$839,457,000	−22.2	$409,729,000	$448,968,000	− 8.8	$1,063,309,000	$1,288,425,000	$35.49†	$40.08†

†—U. S. Average per vehicle.

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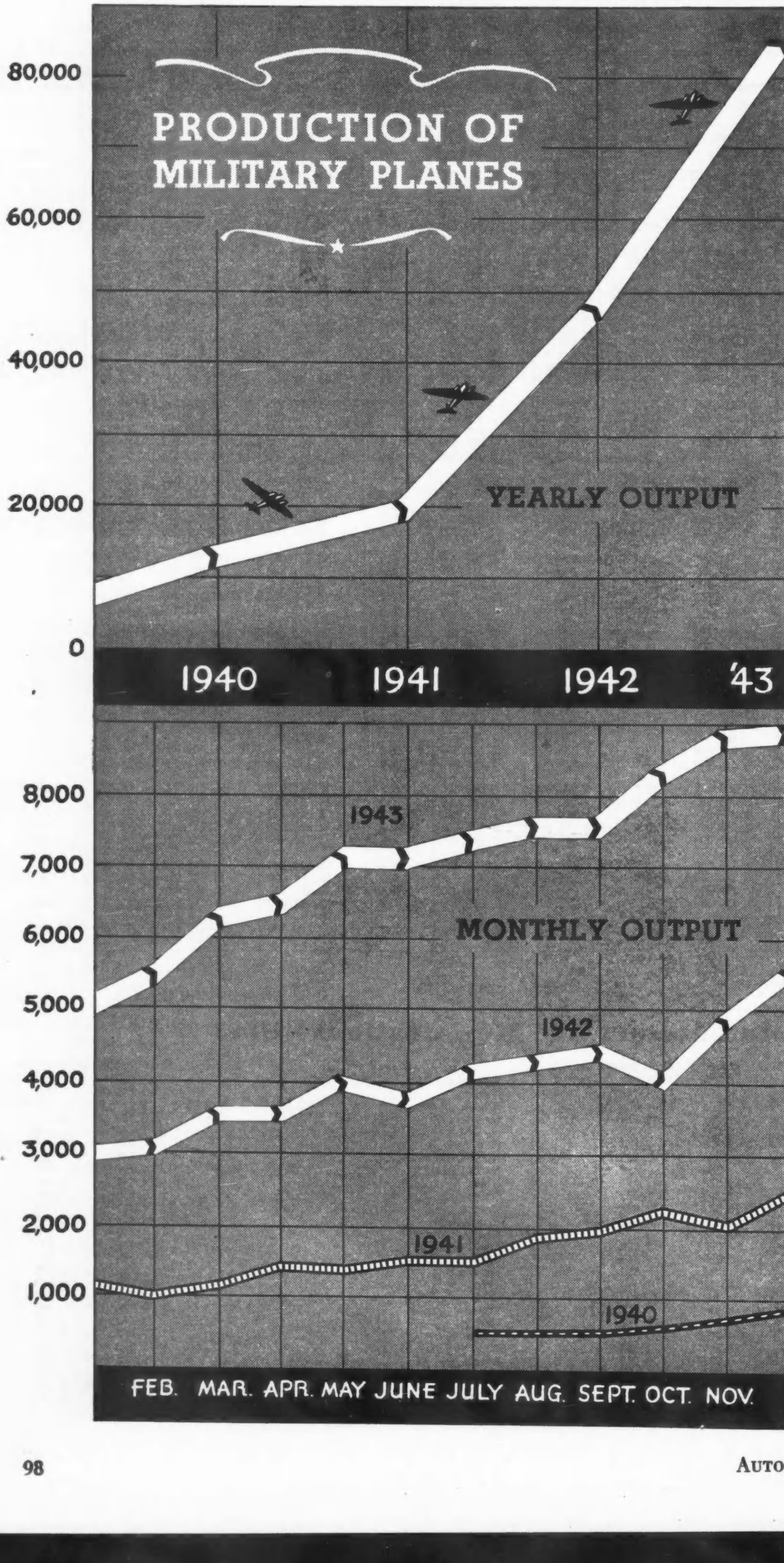
Trailer and Motorcycle Registrations—1943

	Trailers*	Motorcycles
Alabama	5,351	1,897
Arizona	5,304	738
Arkansas	12,594	984
California	176,257	19,414
Colorado	2,002	1,472
Connecticut	6,370	2,737
Delaware	(a)	239
District of Columbia	786	486
Florida	18,378	2,778
Georgia	12,891	2,472
Idaho	16,582	494
Illinois	26,014	8,247
Indiana	81,386	8,423
Iowa	97,556	2,648
Kansas	5,806	2,323
Kentucky	(a)	1,500
Louisiana	14,417	1,998
Maine	10,443	712
Maryland	8,914	2,773
Massachusetts	16,331	1,769
Michigan	154,402	5,838
Minnesota	39,691	2,583
Mississippi	8,931	717
Missouri	42,714	2,887
Montana	4,944	....
Nebraska	46,543	1,431
Nevada	2,700	194
New Hampshire	5,077	357
New Jersey	8,273	5,363
New Mexico	3,114	440
New York	47,008	10,282
North Carolina	546	160
North Dakota	1,100	207
Ohio	124,038	10,885
Oklahoma	7,650	1,395
Oregon	(a)	1,928
Pennsylvania	35,791	13,262
Rhode Island	1,400	1,200
South Carolina	5,415	1,873
South Dakota	25,880	385
Tennessee	(a)	2,000
Texas	45,090	17,644
Utah	651	526
Vermont	2,228	393
Virginia	13,772	3,178
Washington	25,022	2,360
West Virginia	2,890	924
Wisconsin	6,653	3,339
Wyoming	(b)	298
Total	1,178,905	156,131

*—Includes Commercial and Passenger Car. (a)—Included with trucks. (b)—Included with Passenger Cars.



Monthly Output of Military Planes*

Month	Units
1940	
July	561
August	528
September	515
October	617
November	732
December	839
Total	3,792
1941	
January	1,016
February	962
March	1,135
April	1,388
May	1,331
June	1,477
July	1,461
August	1,853
September	1,914
October	2,273
November	2,051
December	2,429
Total	19,290
1942	
January	2,980
February	3,099
March	3,497
April	3,501
May	3,989
June	3,734
July	4,109
August	4,281
September	4,307
October	4,063
November	4,812
December	5,501
Total	47,873
1943	
January	5,013
February	5,453
March	6,264
April	6,472
May	7,114
June	7,094
July	7,373
August	7,612
September	7,598
October	8,362
November	8,789
December	8,802
Total	85,946

* Aircraft Production Board.

Total Weight of Airplanes Produced in 1943, 154% Over 1942 and 766% Over 1941[1]

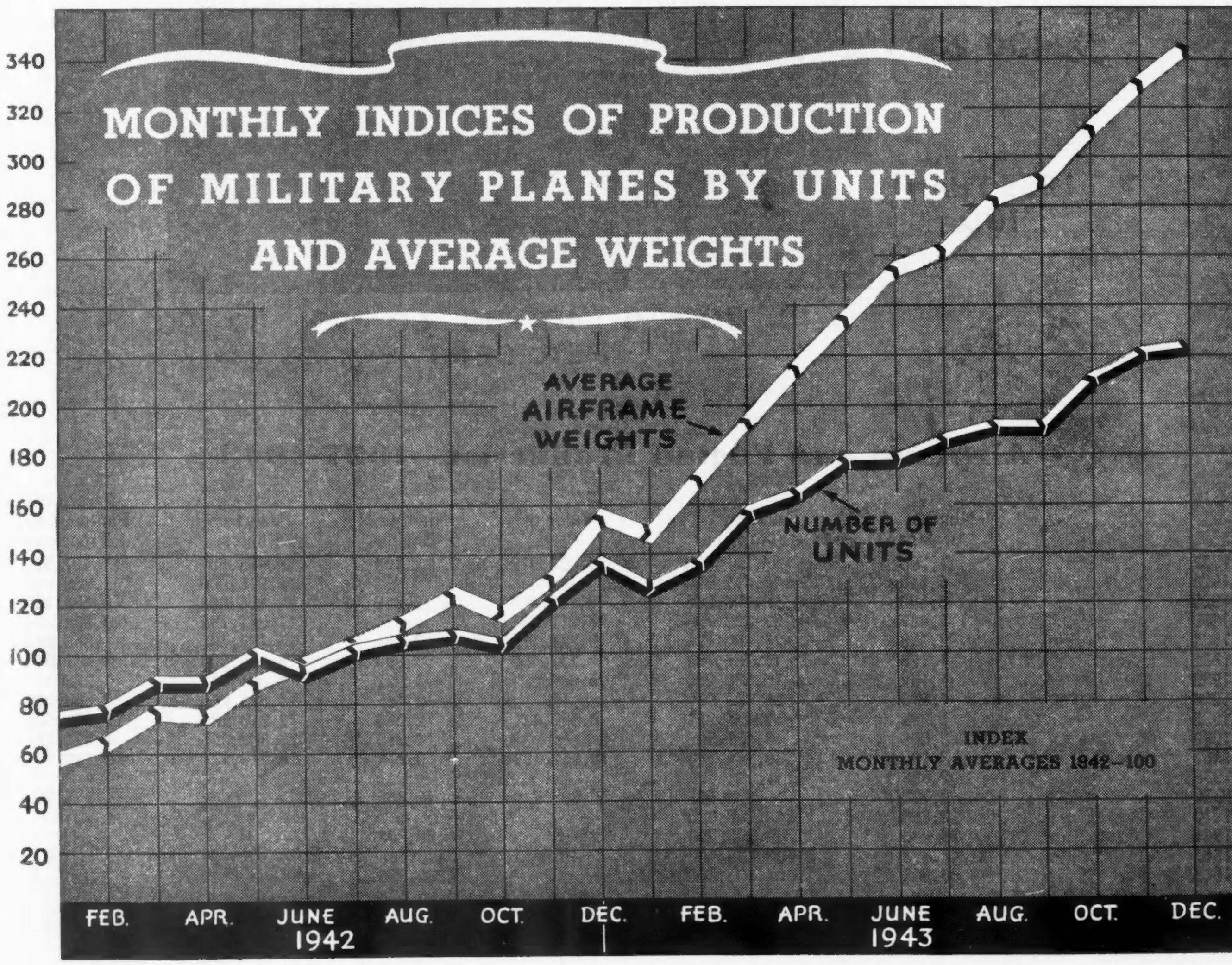
Average Weight per Plane Increased from 4442 lb. in 1941 to 8631 in 1943

	1941		1942		1943	
	Millions of Pounds.	Pounds per Plane.*	Millions of Pounds.	Pounds per Plane.*	Millions of Pounds.	Pounds per Plane.*
January	3.9	3840	14.4	4830	35.9	7160
February	4.4	4570	15.8	5100	41.9	7680
March	4.6	4050	18.8	5380	47.3	7550
April	6.2	4470	18.6	5310	52.7	8140
May	5.8	4360	21.6	5415	57.3	8050
June	6.1	4130	23.1	6190	62.1	8750
July	5.8	3970	25.5	6205	63.7	8640
August	7.8	4210	27.3	6380	69.1	9080
September	8.7	4545	30.1	6990	71.2	9370
October	10.3	4530	28.1	6920	76.1	9100
November	9.3	4530	31.4	6525	80.5	9150
December	12.8	5270	37.9	6890	84.0	9540
Totals	85.7	†4442	292.6	†6112	741.8	†8631

*—Monthly average. †—Annual average per plane [1]—Aircraft Production Board.

Note:—Airframe weights shown include spares which better indicate the production effort of the industry, rather than considering the airframe alone.

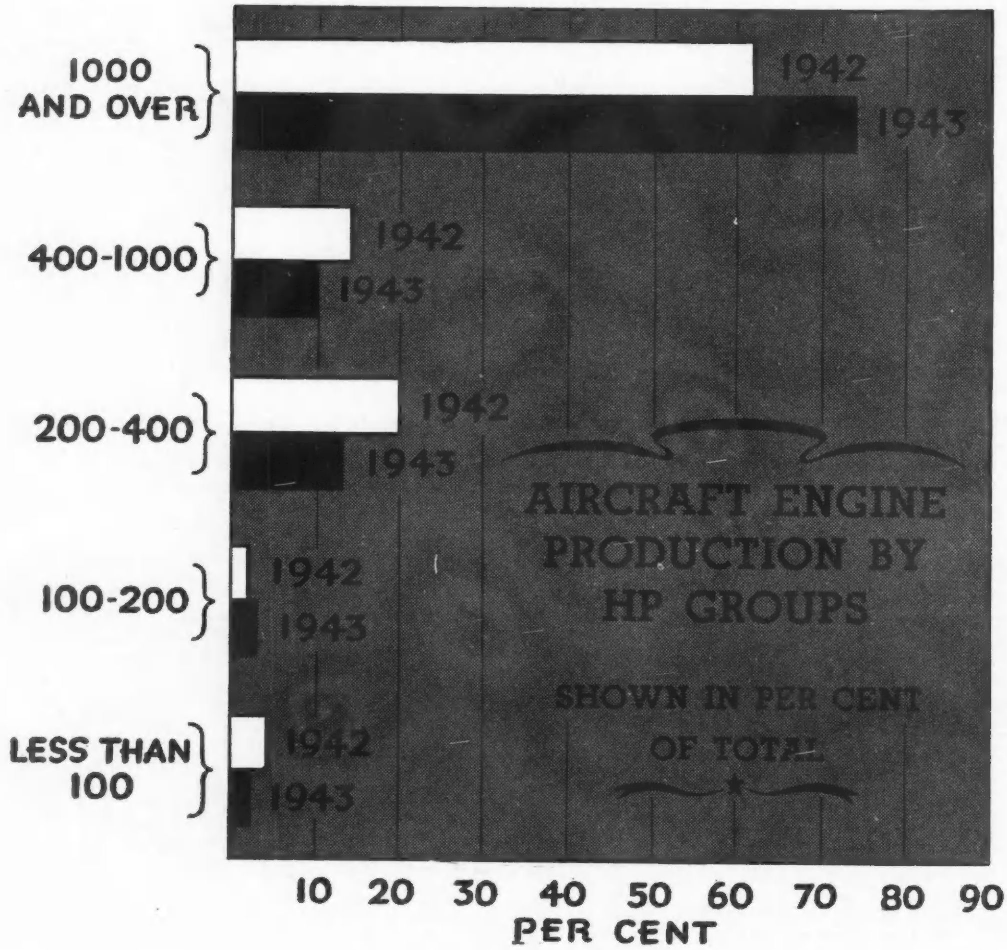
Airframe weight is the weight empty of the airframe less the weight of the engines, superchargers, propellers complete, starters, wheels, tires and tubes, auxiliary power plants, radio complete, batteries, generators, turrets and power operated gun mounts.



Aircraft Engine Production by HP Capacity For Years 1941-1942 and 1943*

	Less than 100 †	100 to 200	200 to 400	400 to 1000	1000 and over	Total Units	Total Take-off HP of Units Produced
1941	.....	.....	......	......	....	50,684	50,747,000**
1942	4,630	2,199	30,138	20,455	91,241	148,663	172,657,000**
1943	4,066	4,559	30,030	22,616	174,067	235,338	332,316,000**

*—Aircraft Production Board. †—Includes 1217 and 127 commercial engines shipped in 1942 and 1943 respectively.
**—Includes spare parts which were about 12% of complete engines for 1941, 15% for 1942 and approximately 31% for 1943.



Airplane and Engine Production—1927-1943*

	Number of Airplanes	Value of Airplanes	Value of Parts	Number of Engines	Value of Engines	Value of Parachutes, Pontoons and Propellers
1927	1,785	$7,187,460	$5,037,519	1,400	$9,493,696	$1,407,929
1928	4,346	43,411,000	(c)	3,496	19,916,000	1,336,000
1929	6,193	50,730,266	10,891,889	6,276	24,966,083	3,528,436
1930	3,437	27,333,736	7,211,992	4,356	17,267,795	3,904,394
1931	2,398	21,600,453	9,224,172	3,794	13,779,791	1,358,093
1932	1,396	15,287,789	4,231,495	1,959	8,902,808	1,497,516
1933	1,152	15,580,255	5,898,282	1,822	8,651,247	1,375,343
1934	1,615	25,399,000	(c)	2,545	15,825,000	2,668,000
1935	1,365	17,454,331	6,527,424	2,866	12,610,285	2,831,580
1936	3,006	47,531,565	(c)	4,295	26,383,055	4,234,273
1937	3,100	38,664,153	19,951,198	6,214	28,576,971	9,129,299
1938	2,698(a)	....	....	......	....	....
1939	3,770(a)	75,872,587(b)	36,687,925	10,355	....	14,513,948
1940	12,636	544,000,000(e)	(f)	......	(f)	(f)
1941	19,290(d)	1,750,000,000(e)	(f)	50,684	(f)	(f)
1942	47,873(d)	5,000,000,000(e)	(f)	148,663	(f)	(f)
1943	85,946(d)	11,000,000,000(e)	(f)	235,338	(f)	(f)

*—Census of Manufacturers. (a)—Production for civil use only.
(b)—Includes value of both military and civilian airplane.
(c)—Included with value of airplanes.
(d)—Aircraft Production Board.
(e)—Includes airplanes, engines and propellers.
(f)—Included with value of airplanes.

★ Operation Statistics of Domestic Air Lines* ★

(Operating in Continental United States)

(As of December 31 of each year)

	1936	1937	1938	1939	1940	1941	1942	1943
Operating companies, number of	21	17	18	17	16	17	16	16
Personnel employed	7,045	7,529	8,955	10,509	15,800	18,984	(1) 26,447	....
Airplanes in service and reserve	272	282	253	265	358	359	179	194
Passenger seats per plane—average	10.67	12.53	13.63	14.63	16.52	17.41	17.60	....
Average speed, miles-per-hour	149	153	153	153	155	159	159	....
Miles flown, revenue	63,777,226	66,971,507	69,668,827	82,571,523	108,800,436	133,022,679	110,102,860	103,601,443
Passengers carried, total	1,020,931	1,102,707	1,343,427	1,876,051	2,959,480	4,060,545	3,551,833	3,454,040
Passenger miles flown(2) (000 omitted)	443,740	476,603	557,719	749,787	1,147,445	1,491,735	1,481,976	1,642,596
Express and freight carried (pounds)	6,928,777	7,127,369	7,335,967	9,514,229	12,506,176	19,209,671	40,101,657	37,543,591
Mail carried (ton miles)	5,741,436	6,698,230	7,422,860	8,584,891	10,035,638	12,900,405	21,066,627	35,873,558
Gasoline consumed, gallons	30,392,923	33,606,770	37,218,743	46,554,856	64,906,284	80,757,892	68,030,246	....
Oil consumed, gallons	675,655	629,127	644,768	726,507	1,087,208	1,258,983	989,103	....

*—Civil Aeronautics Administration. (1)—Estimated. (2)—One passenger one mile.

Operation Statistics of International and Territorial Air Lines*†

(As of December 31 of each year)

	1936	1937	1938	1939	1940	1941	1942	1943
Operating companies, number of	7	7	8	8	8	7	7	
Personnel employed	2,950	4,063	4,354	5,414	6,256	7,474	13,214	
Airplanes in service and reserve	108	104	92	74	82	94	75	
Air line route mileage, unduplicated	32,913	32,901	37,775	44,896	53,025	....	....	
Miles flown, revenue	7,434,500	8,628,730	8,528,412	8,404,540	10,716,827	15,188,865	20,390,260	
Passengers carried, total	108,834	139,955	144,686	168,970	225,798	320,065	392,146	
Passenger miles flown	45,078,586	58,255,487	60,110,655	85,031,146	117,719,111	185,214,555	268,252,356	
Mail, pounds	328,295	426,261	484,712	675,422	1,045,376	1,637,361	3,355,505	
Express and freight, pounds	873,244	1,114,008	1,269,980	1,397,956	1,682,002	3,105,416	8,509,436	
Gasoline consumed, gallons	6,760,898	7,817,614	8,091,449	9,382,279	9,628,645	12,201,504	17,652,754	
Oil consumed, gallons	197,917	215,443	185,102	194,689	200,599	(1) 299,535	(1) 348,039	

*—Civil Aeronautics Administration. (1)—Estimated
†—American companies operating in U. S. Territories and in other countries.

Number of U. S. Airports and Landing Fields*

(As of December 31 of each year)

	1936	1937	1938	1939	1940	1941	1942	1943
Airports and landing fields								
Commercial	774	727	760	801	860	930	1,069	......
Municipal	1,037	1,053	1,092	983	1,031	1,086	1,129	......
Intermediate CAA—lighted	284	278	265	266	289	283	273	......
Intermediate CAA—unlighted	12	5	2	0	0	0	0	......
Army, Navy, Marine Corps, reserve, private and miscellaneous airports	235	236	255	250	151	185	338	......
Total airports in operation	2,342	2,299	2,374	2,280	2,331	2,484	2,809	......
Total lighted airports	705	720	719	735	776	662	700	......

*—Civil Aeronautics Administration.

Number of Certified Civil Aircraft and Pilots—By Years*

(As of December 31 of each year)

	1936	1937	1938	1939	1940	1941	1942	1943
Certificated aircraft								
Airplanes	7,424	9,152	10,000	12,829	17,351	24,836	22,904	......
Glider	31	41	45	44	39	65	104	124
Certificated airmen								
Pilots, airplane, total	15,952	17,681	22,983	31,264	63,113	100,787	110,510	122,884
Airline transport	842	1,064	1,159	1,197	1,431	1,587	2,177	2,315
Commercial	7,288	6,411	7,839	8,280	10,151	15,429	18,808	20,587
Private	7,822	10,206	13,985	21,787	51,531	83,771	89,525	99,982
Pilots, glider	138	161	172	170	138	160	211	1,435
Mechanics	8,738	9,314	9,884	10,296	11,177	14,047	18,097	20,805
Parachute riggers	393	362	397	425	444	618	1,004	1,637
Ground instructors	48	55	92	446	1,948	4,815	7,604	12,739
Student pilot certificates issued (Yearly)								
Airplane	17,675	21,770	15,556	29,839	110,938	93,366	139,289	189,102
Glider	209	125	98	263	419	385	486	1,137

*—Civil Aeronautics Administration.

APPROVED NAMES OF U. S. N

BY TYPE

Army Number	Navy Number	Approved Name	Original Manufacturer
BOMBERS			
B-17	....	Fortress	Boeing
B-18	....	Bolo	Douglas
B-23	....	Dragon	Douglas
B-24	PB4Y	Liberator	Consolidated
B-25	PBJ	Mitchell	North American
B-26	JM	Marauder	Martin
B-29	....	Superfortress	Boeing
B-34	PV	Ventura	Vega (Lockheed)
A-20 (P-70)	BD	Havoc (Boston)*	Douglas
A-24	SBD	Dauntless	Douglas
A-25	SB2C, SBW	Helldiver	Curtiss
A-26	....	Invader	Douglas
A-29	PBO	Hudson	Lockheed
A-30	....	Baltimore	Martin
A-31, A-35	....	Vengeance	Vultee
A-34	SB2A	Bermuda	Brewster
A-36, P-51	....	Mustang	North American
....	TBF, TBM	Avenger	Grumman
OA-10	PBY, PB2B	Catalina	Consolidated
....	PB2Y	Coronado	Consolidated
....	PBM	Mariner	Martin
....	TBD	Devastator	Douglas
....	SB2U	Vindicator	Vought-Sikorsky
FIGHTERS			
P-38	....	Lightning	Lockheed
P-39	....	Airacobra	Bell
P-40	....	Warhawk (Kittyhawk)*	Curtiss
P-43	....	Lancer	Republic
P-47	....	Thunderbolt	Republic
P-51 (A-36)	....	Mustang	North American
P-61	....	Black Widow	Northrop
P-70 (A-20)	....	Havoc (Boston)*	Douglas
....	F4U, FG, F2G	Corsair	Vought-Sikorsky
....	F6F	Hellcat	Grumman
....	F4F, FM	Wildcat	Grumman
....	F2A	Buffalo	Brewster

Army Number	Navy Number	Approved Name	Original Manufacturer
LIAISON			
L-2 (O-57)	....	Grasshopper	Taylorcraft
L-3 (O-58)	....	Grasshopper	Aeronca
L-4 (O-59)	NE	Grasshopper	Piper
L-5 (O-62)	OY	Sentinal	Vultee
OBSERVATION			
O-49	....	Vigilant	Vultee
O-52	....	Owl	Curtiss
O-56 (B-34)	....	Ventura	Lockheed
O-57 (L-2)	....	Grasshopper	Taylorcraft
O-58 (L-3)	....	Grasshopper	Aeronca
O-59 (L-4)	....	Grasshopper	Piper
O-62 (L-5)	....	Sentinal	Vultee
....	SO3C	Seamew	Curtiss
....	OS2U, OS2N	Kingfisher	Vought-Sikorsky
TRAINERS			
AT-6	SNJ	Texan (Harvard)*	North American
AT-7	SNB	Navigator	Beech
AT-10	....	Wichita	Beech
AT-11	SNB	Kansan	Beech
AT-15	....	Crewmaker	Boeing
AT-16	....	Harvard	North American
AT-17 (UC-78)	....	Bobcat (Crane)*	Cessna
AT-18 (A-29)	PBO	Hudson	Lockheed
AT-19	....	Reliant	Vultee
AT-21	....	Gunner	Fairchild
BT-9, BT-14	....	Yale	North American
BT-12	....	Sophomore	Fleetwing
PT-13, PT-17, PT-18, PT-27	N2S	Caydet	Stearman
PT-19, PT-23, PT-26	....	Cornell	Fairchild
PT-21, PT-22	NR	Recruit	Ryan
....	N2T	Tutor	Timm
....	SMC	Falcon	Curtiss
BT-13, BT-15	SN-V1	Valiant	Vultee
TRANSPORTS			
C-43	GB	Traveller	Beech
C-45	JRB	Expeditor	Beech
C-46	R5C	Commando	Curtiss
C-47	R4D	Skytrain (Dakota)*	Douglas
C-49, C-53	R4D	Skytrooper (Dakota)*	Douglas
C-54	R5D	Skymaster	Douglas
C-56, C-60	R50	Lodestar	Lockheed
UC-61	GK	Forwarder (Argus)*	Fairchild
....	GH	Nightingale	Howard
C-63 (AT-18)	....	....	Lockheed
C-69	....	Constellation	Lockheed
C-76	....	Caravan	Curtiss
UC-78 (AT-17)	JRC	Bobcat	Cessna
C-87	RY	Liberator	Consolidated
....	JR2S	Excalibur	Vought-Sikorsky
OA9	JRF	Goose	Grumman
....	J4F	Widgeon	Grumman

*—Names contained within parentheses are designations adopted previously by the British and used in their official records, publications and communications.

S. MILITARY AIRCRAFT

BY NAME

Approved Name	Type Airplane	Army Number	Navy Number	Original Manufacturer
Aeronca Grasshopper	Liaison	L-3	....	Aeronca
Aeronca Grasshopper	Observation	O-58	....	Aeronca
Airacobra	Fighter	P-39	....	Bell
Avenger	Bomber	....	TBF, TBM	Grumman
Baltimore	Bomber	A-30	....	Martin
Bermuda	Bomber	A-34	SB2A	Brewster
Black Widow	Fighter	P-61	....	Northrop
Bobcat	Trainer	AT-17	....	Cessna
Bobcat	Transport	UC-78	JRC	Cessna
Bolo	Bomber	B-18	....	Douglas
Buffalo	Fighter	....	F2A-3	Brewster
Caravan	Transport	C-76	....	Curtiss
Catalina	Bomber	OA-10	PBY, PB2B, PBM	Consolidated
Caydet	Trainer	PT-13, PT-17 PT-18, PT-27	N2S	Stearman
Commando	Transport	C-46	R5C	Curtiss
Constellation	Transport	C-69	....	Lockheed
Cornell	Trainer	PT-19, 23, 26	....	Fairchild
Coronado	Bomber	....	PB2Y	Consolidated
Corsair	Fighter	....	F4U, FG, F2G	Vought-Sikorsky
Crewmaker	Trainer	AT-15	....	Boeing
Dauntless	Bomber	A-24	SBD	Douglas
Devastator	Bomber	....	TBD	Douglas
Dragon	Bomber	B-23	....	Douglas
Exaliber	Transport	....	JR2S	Vought-Sikorsky
Expeditor	Transport	C-45	JRB	Beech
Falcon	Trainer	....	SNC	Curtiss
Fortress	Bomber	B-17	....	Boeing
Forwarder	Transport	UC-61	GK	Fairchild
Goose	Transport	OA-9	JRF	Grumman
Gunner	Trainer	AT-21	....	Fairchild
Harvard	Trainer	AT-16	....	North American
Havoc	Bomber	A-20	BD	Douglas
Havoc	Fighter	P-70	....	Douglas
Hellcat	Fighter	....	F6F	Grumman
Helldiver	Bomber	A-25	SB2C, SBW	Curtiss
Hudson	Bomber	A-29	PBO	Lockheed
Hudson	Trainer	AT-18	PBO	Lockheed
Hudson	Transport	C-63	....	Lockheed
Invader	Bomber	A-26	....	Douglas
Kansan	Trainer	AT-11	SNB	Beech
Kingfisher	Observation	....	OS2U, OS2N	Vought-Sikorsky
Lancer	Fighter	P-43	....	Republic
Liberator	Bomber	B-24	PB4Y	Consolidated
Liberator	Transport	C-87	RY	Consolidated
Lightning	Fighter	P-38	....	Lockheed
Lodestar	Transport	C-56, C-60	R5O	Lockheed
Marauder	Bomber	B-26	JM	Martin
Mariner	Bomber	....	PBM	Martin
Mitchell	Bomber	B-25	PBJ	North American
Mustang	Bomber	A-36	....	North American
Mustang	Fighter	P-51	....	North American
Navigator	Trainer	AT-7	SNB	Beech
Nightingale	Transport	....	GH	Howard
Owl	Observation	O-52	....	Curtiss
Piper Grasshopper	Liaison	L-4	NE	Piper
Piper Grasshopper	Observation	O-59	....	Piper
Recruit	Trainer	PT-21, 22	NR	Ryan
Reliant	Trainer	AT-19	....	Vultee
Seaview	Observation	....	SO3C	Curtiss
Sentinel	Liaison	L-5	OY	Vultee
Sentinel	Observation	O-62	....	Vultee
Skymaster	Transport	C-54	R5D	Douglas
Skytrain	Transport	C-47	R4D	Douglas
Skytrooper	Transport	C-49, C-53	R4D	Douglas
Sophomore	Trainer	BT-12	....	Fleetwing
Superfortress	Bomber	B-29	....	Boeing
Taylorcraft Grasshopper	Liaison	L-2	....	Taylorcraft
Taylorcraft Grasshopper	Observation	O-57	....	Taylorcraft
Texan	Trainer	AT-6	SNJ	North American
Thunderbolt	Fighter	P-47	....	Republic
Traveller	Transport	C-43	GB	Beech
Tutor	Trainer	....	N2T	Timm
Valiant	Trainer	BT-13, BT-15	SN-VI	Vultee
Vengeance	Bomber	A-31, A-35	....	Vultee
Venture	Bomber	B-34	PV	Vega (Lockheed)
Ventura	Observation	O-56	....	Lockheed
Vigilant	Observation	O-49	....	Vultee
Vindicator	Bomber	....	SB2U	Vought-Sikorsky
Warhawk	Fighter	P-40	....	Curtiss
Wichita	Trainer	AT-10	....	Beech
Widgeon	Transport	....	J4F	Grumman
Wildcat	Fighter	....	F4F, FM	Grumman
Yale	Trainer	BT-9, BT-14	....	North American

RUBBER

Number of Tires Released—1943

(Passenger Car Sizes Only)

Kind of Tire	Number of Tires Released
New Synthetic Tires	5,000,000
Pre-War Tires	4,500,000
Reclaimed Rubber Tires	1,700,000
Used Tires	3,800,000
Emergency Tires	2,200,000
Total Tires Released—1943	17,200,000
Yearly Average, Pre-War	50,000,000

Reclaiming and Recapping—1943

Camelback

167,000,000 lb. for passenger car tires
59,000,000 lb. for truck and bus tires

226,000,000 lb. for all tires—1943
105,000,000 lb. for all tires—1942

Use of Crude and Synthetic Rubber—Actual and Estimated, 1943-1944

(In Tons of 2240 lb.)

Use	1943 Actual First Falf	1943 Actual Third Quarter	1943 Estimated Fourth Quarter	1943 Estimated Total	1944 Estimated First Half	1944 Estimated Second Half	1944 Estimated Total
Military	132,100	68,300	68,000	268,400	167,000	223,000	390,000
Trucks and buses	36,900	23,500	21,000	81,400	64,000	81,000	145,000
Passenger size tires	5,300	13,200	24,000	42,500	78,000	106,000	184,000
Other indirect military and civilian	14,200	8,900	9,000	32,100	19,000	19,000	38,000
Total—United States	188,500	113,900	122,000	424,400	328,000	429,000	757,000
Exports	24,400	16,100	33,000	73,500	70,000	76,000	146,000
Canada	17,600	7,500	8,000	33,100	25,000	25,000	50,000
Total—All Uses	230,500	137,500	163,000	531,000	423,000	530,000	953,000

1943-1944 Estimated Quarterly Production of Synthetic Rubber

(In Tons of 2240 lb.)

Type of Synthetic Rubber	1943					1944				
	1	2	3	4	Total	1	2	3	4	Total
Buna-S	3,102	18,792	56,741	105,000	183,635	145,000	185,000	190,000	190,000	710,000
Butyl	35	393	364	1,500	2,292	4,000	6,000	12,000	17,000	39,000
Neoprene	4,372	5,853	10,049	12,300	32,574	12,300	12,300	12,300	12,300	49,200
Buna-N	2,977	3,335	4,063	4,500	14,875	5,000	5,000	5,000	5,000	20,000
Total Synthetic	10,486	28,373	71,217	123,300	233,376	166,300	208,300	219,300	224,300	818,200

Quarterly Supply and Essential Requirements of Rubber—1943-1944* United States and Canada

(In Tons of 2240 lb.)

	1943				1944				
	1	2	3	4	1	2	3	4	
Requirements	111,400	230,400	368,000	531,000	200,000	423,000	678,000	953,000	Requirements
Supply	30,500	73,000	153,200	293,000	187,000	415,000	654,000	899,000	Supply
Stocks; end of quarter	362,100	285,600	228,200	205,000	192,000	197,000	181,000	151,000	Stocks; end of quarter

*—All data are on a cumulative basis. Resultant stocks obtained by subtracting difference between requirements and supply from initial stock of 443,000 tons for 1943 and 205,000 for 1944.

Steel Production by Years—1917-1943

(Ingots and Steel for Castings)

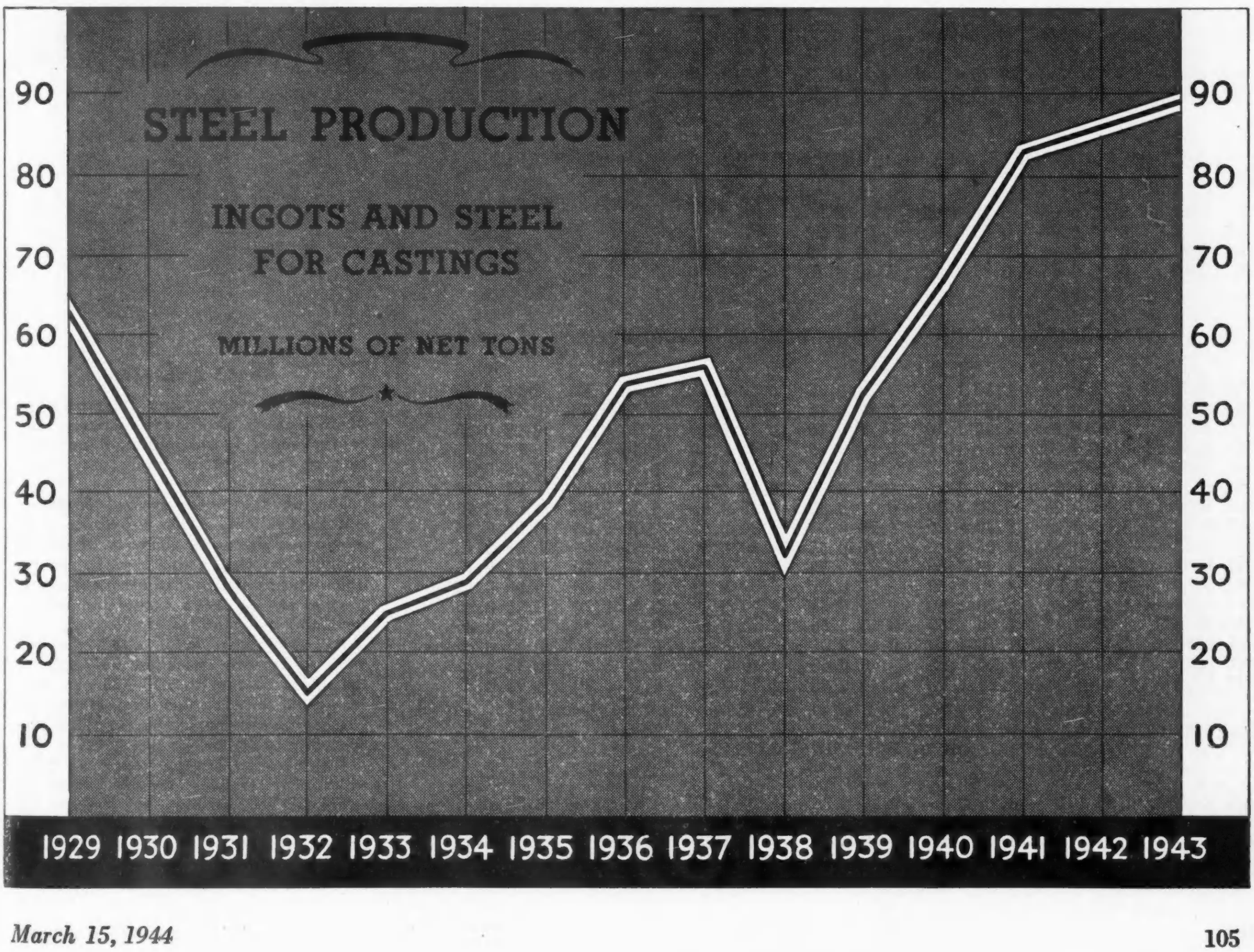
Year	Net Tons	Per Cent of Capacity	Year	Net Tons	Per Cent of Capacity	Year	Net Tons	Per Cent of Capacity
1917	49,787,196	....	1926	52,912,011	84.1	1935	38,183,705	48.7
1918	49,010,095	....	1927	49,272,671	75.4	1936	53,499,999	68.4
1919	38,099,180	....	1928	56,623,009	84.6	1937	56,636,945	72.5
1920	46,183,227	....	1929	61,741,962	88.7	1938	31,751,990	39.6
1921	21,638,719	....	1930	44,590,808	62.8	1939	52,798,714	64.5
1922	38,945,226	....	1931	28,607,310	38.0	1940	66,982,686	82.1
1923	49,016,991	....	1932	15,123,477	19.7	1941	82,839,259	97.3
1924	41,445,868	....	1933	25,724,643	33.5	1942	86,029,931	96.8
1925	40,704,893	....	1934	29,181,924	37.4	1943	88,872,598	98.1

Steel Production By Type—By Years—1934-1943 *

(Net Tons of Ingots and Steel for Castings)

	Open Hearth									
	Basic	Acid	Total	Per Cent of Total	Bessemer	Per Cent of Total	Crucible	Electric	Per Cent of Total	Total
1934	24,047,187	307,651	26,354,838	90.3	2,421,840	8.3	595	404,651	1.4	29,181,124
1935	34,004,585	396,695	34,401,280	90.1	3,175,235	8.3	719	606,471	1.6	38,183,705
1936	42,288,605	471,858	48,760,463	91.1	3,873,472	7.2	914	865,150	1.7	53,499,999
1937	41,265,211	559,768	51,824,979	91.5	3,863,918	6.8	1,046	947,002	1.7	56,636,945
1938	28,774,999	305,017	29,008,016	91.6	2,106,340	6.6	7	565,627	1.8	31,751,990
1939	47,828,700	581,100	48,409,800	91.7	3,358,916	6.4	931	1,029,067	1.9	52,798,714
1940	60,882,840	690,243	61,573,083	91.9	3,708,573	5.5	1,024	1,700,006	2.6	66,982,686
1941	73,312,851	1,076,768	74,389,619	89.8	5,578,017	6.7	2,313	2,869,256	3.5	82,839,259
1942	....	....	76,501,957	88.9	5,553,424	6.5	.....	3,974,540	4.6	86,029,921
1943	....	....	78,625,857	88.5	5,625,279	6.3	.....	4,621,462	5.2	88,872,598

*—American Iron and Steel Institute



National Emergency Steel Compositions*

Revised August 15, 1943

CARBON-MANGANESE STEELS

	C	Mn	Si			
NE 1330	0.28–0.33	1.60–1.90	0.20–0.35	....	....	....
NE 1335	0.33–0.38	1.60–1.90	0.20–0.35	....	....	....
NE 1340	0.38–0.43	1.60–1.90	0.20–0.35	....	....	....
NE 1345	0.43–0.48	1.60–1.90	0.20–0.35	....	....	....
NE 1350	0.48–0.53	1.60–1.90	0.20–0.35	....	....	....

NICKEL-CHROMIUM-MOLYBDENUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 8613	0.12–0.17	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8615	0.13–0.18	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8617	0.15–0.20	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8620	0.18–0.23	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8630	0.28–0.33	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8635	0.33–0.38	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8637	0.35–0.40	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8640	0.38–0.43	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8642	0.40–0.45	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8645	0.43–0.48	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8650	0.48–0.53	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.70	0.15–0.25
NE 8720	0.18–0.23	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.70	0.20–0.30

SILICON-MANGANESE AND SILICON-MANGANESE-CHROMIUM STEELS

	C	Mn	Si	Cr		
NE 9255	0.50–0.60	0.70–0.95	1.80–2.20	....	....	....
NE 9260	0.55–0.65	0.75–1.00	1.80–2.20	....	....	....
NE 9261	0.55–0.65	0.75–1.00	1.80–2.20	0.10–0.25	....	....
NE 9262	0.55–0.65	0.75–1.00	1.80–2.20	0.25–0.40	....	....

MANGANESE-NICKEL-CHROMIUM-MOLYBDENUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 9415	0.13–0.18	0.80–1.10	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9420	0.18–0.23	0.80–1.10	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9422	0.20–0.25	0.80–1.10	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9425	0.23–0.28	0.80–1.10	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9430	0.28–0.33	0.90–1.20	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9435	0.33–0.38	0.90–1.20	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9437	0.35–0.40	0.90–1.20	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9440	0.38–0.43	0.90–1.20	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9442	0.40–0.45	1.00–1.30	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9445	0.43–0.48	1.00–1.30	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9450	0.48–0.53	1.20–1.50	0.20–0.35	0.30–0.50	0.30–0.60	0.08–0.15
NE 9537	0.35–0.40	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.70	0.15–0.25
NE 9540	0.38–0.43	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.70	0.15–0.25
NE 9545	0.43–0.48	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.70	0.15–0.25
NE 9542	0.40–0.45	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.70	0.15–0.25
NE 9550	0.48–0.53	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.70	0.15–0.25

CARBON-CHROMIUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 52100A	0.95–1.10	0.25–0.45	0.20–0.35	1.30–1.60	0.35 max.	0.08 max.
NE 52100B	0.95–1.10	0.25–0.45	0.20–0.35	0.90–1.15	0.35 max.	0.08 max.
NE 52100C	0.95–1.10	0.25–0.45	0.20–0.35	0.40–0.60	0.35 max.	0.08 max.

* Courtesy American Iron and Steel Institute.

Revisions

Conditions surrounding the production of alloy steels have made necessary certain changes in the chemical composition of the National Emergency (N.E.) Steels.

The changes were made to permit greater flexibility in the use of scrap; to make possible higher recovery of molybdenum from steel scrap; and to remove objections on the part of steel consumers to the use of steels containing higher than normal quantities of silicon.

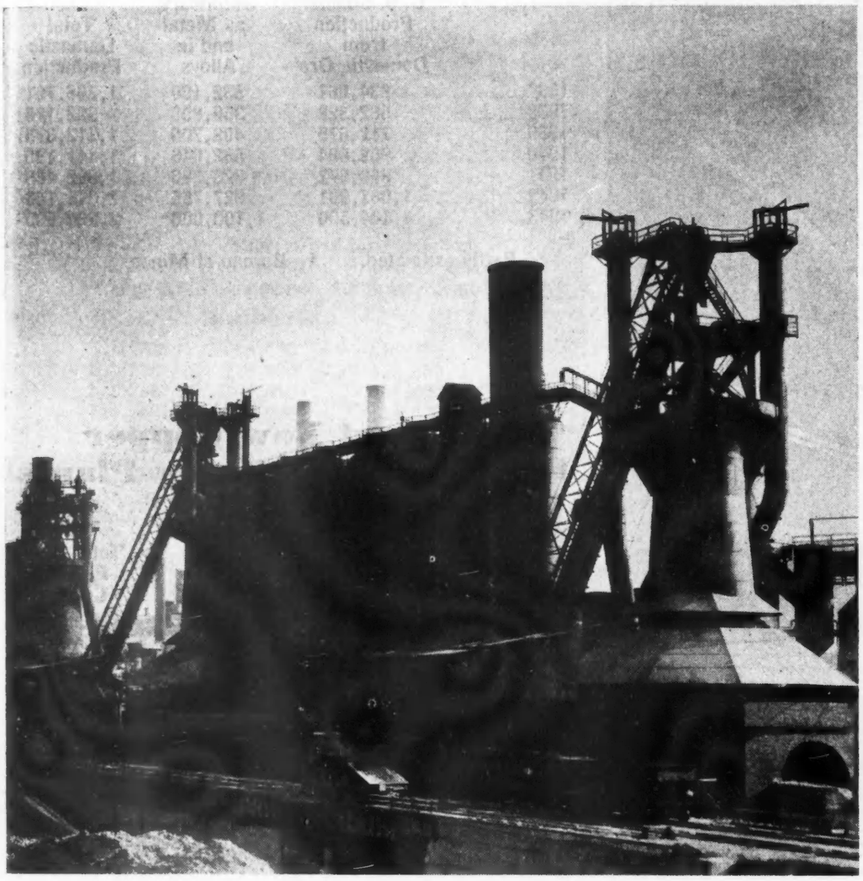
To accomplish these ends, the NE 9400 series were modified by reducing the silicon content to 0.20-0.35 per cent; increasing the chromium content to 0.30-0.50 per cent; and increasing the nickel content to 0.30-0.60 per cent.

The following compositions have been withdrawn: NE 8020, NE 8442, and the entire NE 9600 series.

The following compositions have been added: NE 9261, 9425, and NE 9545.

The chromium content of NE 9262 was revised to read 0.25-0.40 per cent.

★ IRON AND STEEL SCRAP ★



Stocks of Scrap and Pig Iron

As of December 31 of Each Year
(Short Tons)

STEEL SCRAP

Year	Home	Purchased	Total
1939	2,022,000	3,398,000	5,420,000
1940	1,837,000	3,815,000	5,652,000
1941	1,167,000	2,635,000	3,802,000
1942	1,600,000	4,674,000	6,274,000
1943	1,701,000	4,228,000	5,929,000

IRON AND SCRAP

Year	Pig Iron †	Steel Scrap	Total Pig Iron and Scrap
1939	3,667,000	5,420,000	9,087,000
1940	3,138,000	5,652,000	8,790,000
1941	1,581,000	3,802,000	5,383,000
1942	1,425,000	6,274,000	7,699,000
1943	1,572,000	5,929,000	7,501,000

†—At consumers' and suppliers' yards

Iron and Steel Scrap Consumption by Years—1936-1943

(Short Tons)

Year	Scrap: Home	Scrap: Purchased	Scrap: Total	Pig Iron	Total Scrap and Pig Iron
1936	21,169,556	19,551,553	40,721,109	33,710,470	74,431,579
1937	22,255,557	20,311,468	42,567,025	38,143,310	80,710,335
1938	12,679,902	11,226,424	23,906,326	20,724,871	44,631,197
1939	19,621,896	16,704,640	36,326,536	35,232,699	71,559,235
1940	25,047,723	19,481,948	44,529,671	46,185,828	90,715,499
1941	33,904,680	25,311,576	59,216,256	56,185,472	115,401,728
1942	34,094,000	26,457,000	60,551,000	59,253,000	119,804,000
1943	35,045,000	26,652,000	61,697,000	62,776,000	124,473,000

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Consumption by Months—1943

(Short Tons)

Month	Scrap: Home	Scrap: Purchased	Scrap: Total	Pig Iron	Total Scrap and Pig Iron
January	2,856,000	2,175,000	5,031,000	5,057,000	10,088,000
February	2,600,000	2,080,000	4,680,000	4,661,000	9,341,000
March	3,007,000	2,354,000	5,361,000	5,219,000	10,580,000
April	2,938,000	2,261,000	5,199,000	4,954,000	10,153,000
May	2,990,000	2,299,000	5,289,000	5,052,000	10,341,000
June	2,855,000	2,177,000	5,032,000	4,748,000	9,780,000
July	2,919,000	2,200,000	5,119,000	5,010,000	10,129,000
August	3,036,000	2,212,000	5,248,000	5,174,000	10,422,000
September	3,000,000	2,215,000	5,215,000	5,120,000	10,335,000
October	3,112,000	2,297,000	5,409,000	5,271,000	10,680,000
November	2,884,000	2,247,000	5,131,000	5,001,000	10,132,000
December	2,848,000	2,135,000	4,983,000	5,019,000	10,002,000

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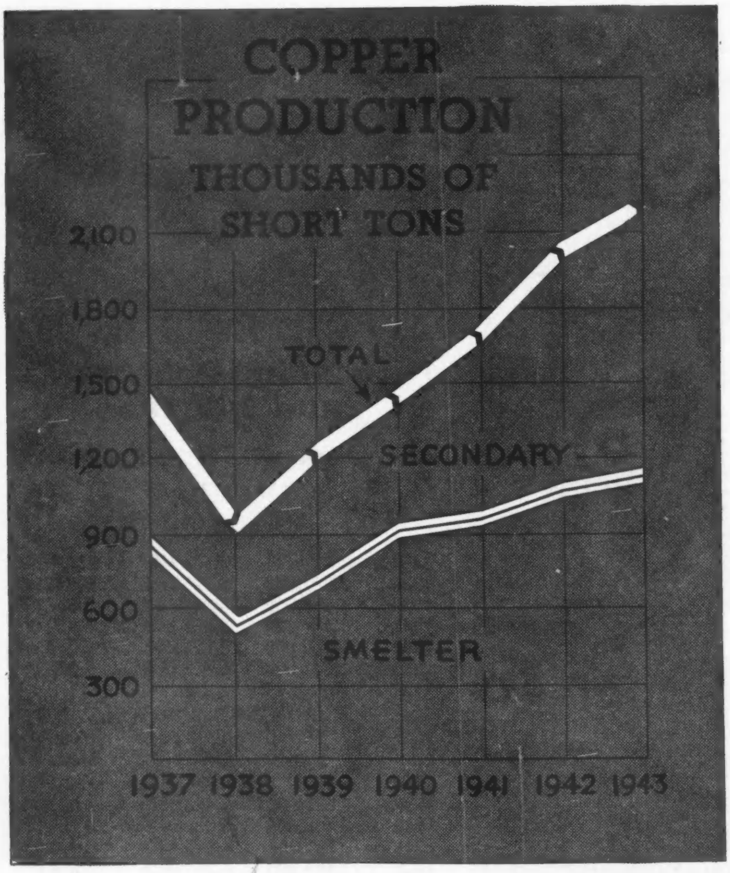
★ COPPER ★ ★ ★ ★



Production in Short Tons[†]

	U. S. Smelter Production from Domestic Ore	Secondary as Metal and in Alloys	Total Domestic Production
1937.........	834,661	532,100	1,366,761
1938.........	562,328	359,800	922,128
1939.........	712,675	499,700	1,212,375
1940.........	909,084	532,046	1,441,130
1941.........	966,072	726,396	1,692,468
1942.........	1,087,991	927,755	2,015,746
1943.........	1,104,500	1,100,000*	2,204,500*

*—Partly estimated. †—Bureau of Mines.

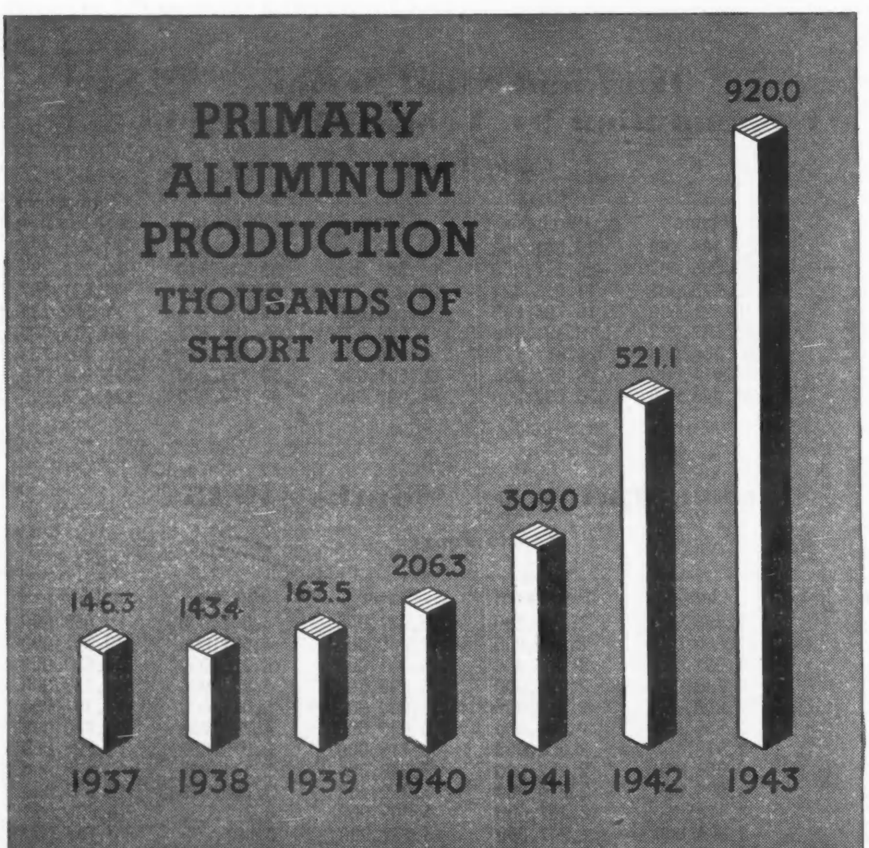
Refined New Copper Produced at Primary Plants[†]

(In Short Tons)

	From Domestic Ores	From Foreign Ores	Total New Refined Copper
1937.........	822,253	244,561	1,066,814
1938.........	552,574	239,842	792,416
1939.........	704,873	304,642	1,009,515
1940.........	927,239	386,317	1,313,556
1941.........	975,408	419,901	1,395,309
1942.........	1,064,792	349,769	1,414,561
1943.........	1,071,500	308,000	1,379,500

†—Bureau of Mines.

ALUMINUM



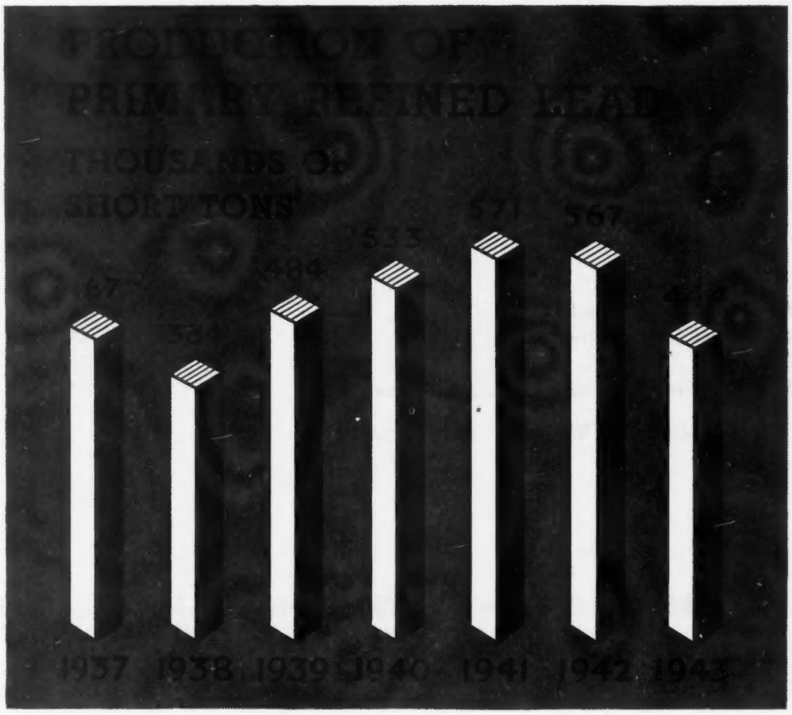
Primary Aluminum*

(Short Tons)

	Production	Apparent Consumption
1930.......	114,518	70,932
1931.......	88,735	58,497
1932.......	52,649	34,844
1933.......	42,549	51,269
1934.......	37,088	68,281
1935.......	59,644	95,823
1936.......	112,466	137,722
1937.......	146,340	167,979
1938.......	143,441	89,523
1939.......	163,545	167,645
1940.......	206,280	227,017
1941.......	309,067	302,788
1942.......	521,106	588,522
1943.......	920,000	....

*—Bureau of Mines.

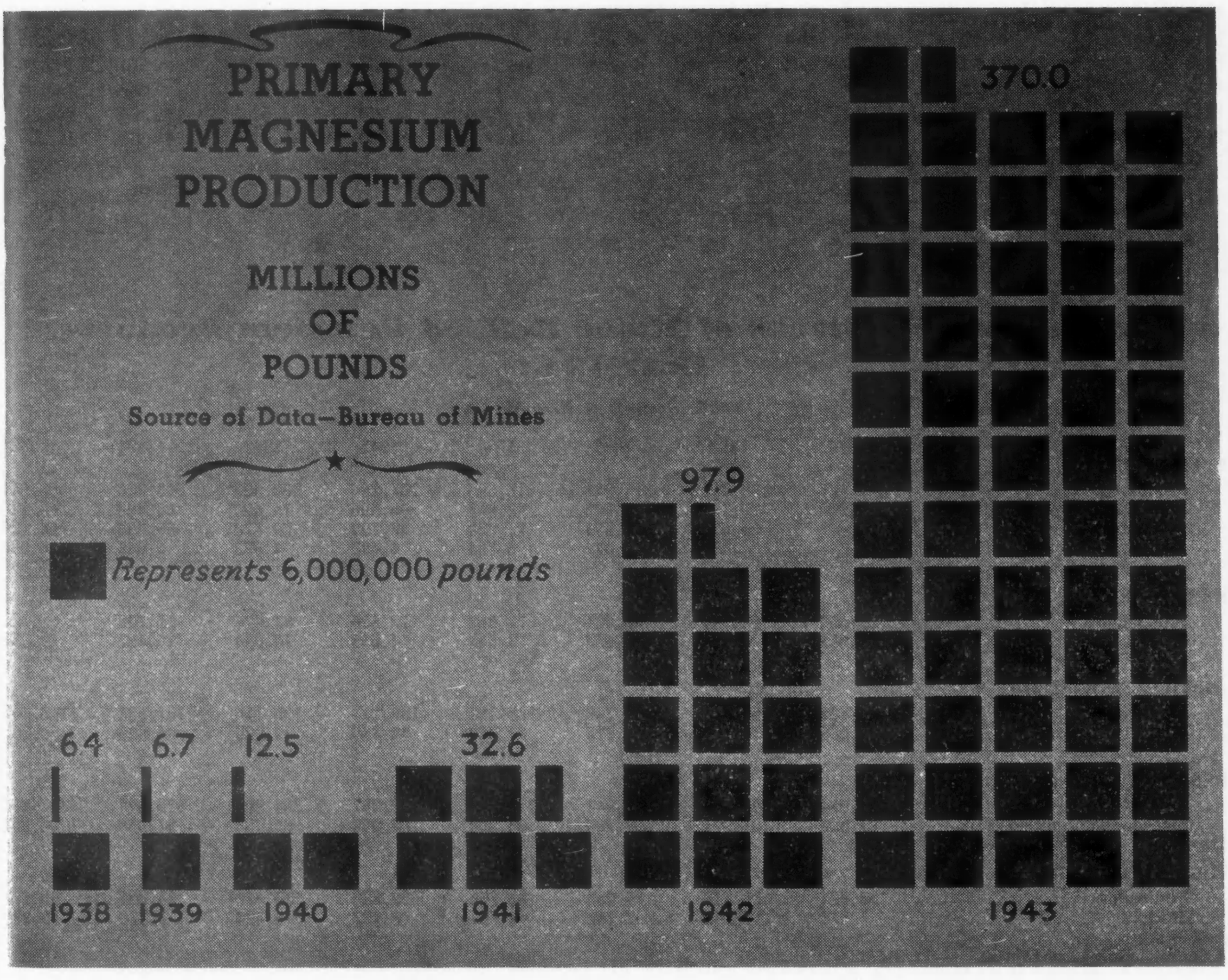
★ ★ ★ ★ LEAD ★ ★



Lead Production

	Refined Primary Lead Produced	Supply Available for Consumption	Apparent Consumption of Primary and Secondary Lead
	(In Short Tons)		
1932	281,941	258,469	416,700
1933	263,676	240,904	449,500
1934	311,236	305,610	488,000
1935	324,560	318,900	538,900
1936	399,156	383,433	633,550
1937	467,317	449,464	678,700
1938	383,669	339,708	546,000
1939	484,035	415,031	667,000
1940	533,179	633,989	782,000
1941	570,967	830,797	906,061
1942	566,839	927,522	996,124
1943	443,548	N.A.	N.A.

Source—Bureau of Mines. N.A.—Not available.



Shipments of Motor Fuel by Pipe Line in U. S.—1939-1943

(Thousands of Barrels)

	1939	1940	1941	1942	1943†	1942†
Motor fuel turned into lines	95,123	97,064	112,976	126,232	186,974	113,802
Motor fuel delivered from lines	94,708	96,657	111,077	125,341	184,649	114,078
Shortage	262	588	615	677	953	587
Stocks in lines and working tanks, end of period	5,255	5,074	6,358	6,572	7,944	5,495

Source—Bureau of Mines. †—Eleven months.

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Oil and Gas Wells Drilled in the United States—1939-1943

	Oil			Gas		Dry		Total Wells Drilled	
	Number	Per Cent of Total Drilled	Average Initial Production* (Barrels)	Number	Per Cent of Total Drilled	Number	Per Cent of Total Drilled	Number	Per Cent
1939	17,485	67.28	386	2,145	8.25	6,357	24.47	25,987	100.00
1940	19,125	68.00	396	2,382	8.47	6,617	23.53	28,124	100.00
1941	19,195	66.03	...	2,990	10.29	6,885	23.68	29,070	100.00
1942	10,302	57.44	...	2,100	11.71	5,532	30.85	17,934	100.00
1942—11 Mos.	9,498	57.64	280	1,943	11.79	5,038	30.57	16,479	100.00
1943—11 Mos.	8,835	54.62	190	1,672	10.34	5,669	35.04	16,176	100.00

Source—Bureau of Mines. *—Per Well.

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Production and Stocks of Major Refined Petrolem Products 1937-1943

(Thousands of Barrels)

	1937	1938	1939	1940	1941	1942	1943†	1942†
MOTOR FUEL								
Production	571,727	569,162	611,043	616,695	701,294	608,900	553,336	559,941
Stocks, end of period	74,650	70,779	81,722	83,647	90,596	75,404	64,499	69,220
Finished Gasoline	....	65,949	77,301	77,943	86,159	70,772	59,854	64,224
Natural Gasoline	....	4,830	4,421	5,704	4,437	4,632	4,645	4,996
KEROSENE								
Production	65,308	64,580	68,521	73,882	72,586	67,474	65,745	62,123
Stocks, end of period	7,083	7,799	7,576	9,512	14,515	10,064	10,487	12,630
DISTILLATE FUEL OIL								
Production	146,706	151,774	161,746	183,304	189,177	196,714	191,585	178,641
Stocks	22,566	36,224	33,718	42,940	49,330	44,920	44,806	50,709
RESIDUAL FUEL OIL								
Production	312,064	294,890	305,944	316,221	342,367	358,901	379,344	327,014
Stocks, end of period	81,507	101,971	92,290	89,304	82,959	61,783	53,046	66,661
LUBRICATING OIL								
Production	35,321	30,826	35,036	36,765	39,539	38,626	35,462	35,577
Stocks	7,512	7,695	7,142	8,767	8,127	9,424	7,770	9,336

Source—Bureau of Mines. †—11 Months.

Gasoline Prices †

Average of 50 Representative Cities in the United States

Year	Service Station (Ex. Tax)	State Gasoline Tax	Service Station (Inc. Tax)	Year	Service Station (Ex. Tax)	State Gasoline Tax	Service Station (Inc. Tax)
1920	29.74	.09	29.83	1932	13.30	4.63*	17.93
1921	26.11	.20	26.31	1933	12.41	5.41*	17.82
1922	24.82	.38	25.20	1934	13.64	5.21*	18.85
1923	21.06	.91	21.97	1935	13.55	5.29*	18.84
1924	19.46	1.48	20.94	1936	14.10	5.35*	19.45
1925	20.09	2.11	22.20	1937	14.59	5.40*	19.99
1926	20.97	2.41	23.38	1938	14.07	5.44*	19.51
1927	18.28	2.81	21.09	1939	13.31	5.44*	18.75
1928	17.90	3.04	20.94	1940	12.75	5.66*	18.41
1929	17.92	3.50	21.42	1941	13.30	5.93*	19.23
1930	16.16	3.79	19.95	1942	14.46	5.97*	20.43
1931	12.98	4.00	16.98	1943	14.56	5.97*	20.53

*—Including the Federal tax of one cent on gasoline which became effective June 21, 1942. On June 17, 1933 it was increased to 1½ cents per gallon; on January 1, 1943 decreased to one cent per gallon; and on July 1, 1940 again increased to 1½ cents per gallon.

†—American Petroleum Institute from data compiled by The Texas Company.

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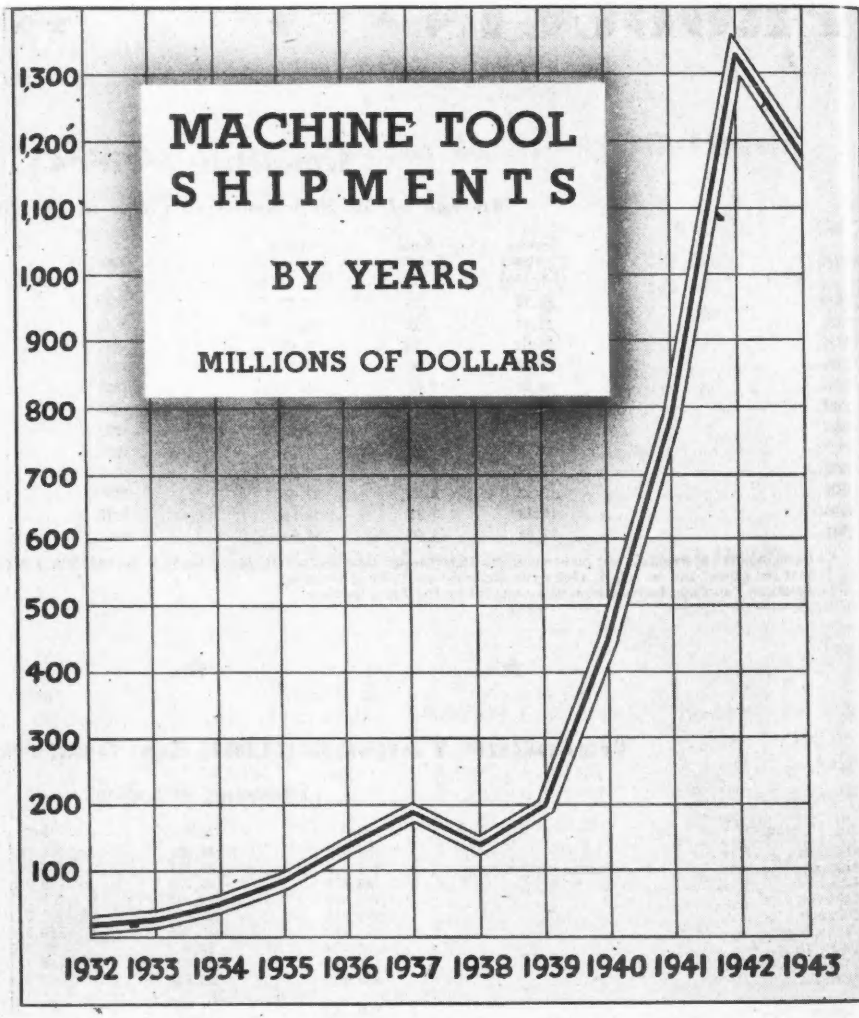
Gasoline Consumption by States—1938-1943

(Thousand of Gallons)

State	1938	1939	1940	1941	1942	1943†
Alabama	230,277	246,507	264,908	328,414	309,800	253,200
Arizona	102,526	107,114	110,716	128,157	127,207	120,270
Arkansas	169,679	182,233	190,925	224,278	206,773	175,130
California	1,752,332	1,837,912	1,927,973	2,152,549	2,235,256	2,361,090
Colorado	226,965	237,669	251,012	267,029	244,931	242,650
Connecticut	326,262	345,105	380,876	421,468	337,459	253,200
Delaware	55,776	58,428	62,799	68,118	54,607	48,530
District of Columbia	139,291	149,978	169,127	191,552	149,733	103,390
Florida	338,603	365,830	407,939	475,696	441,126	356,590
Georgia	338,787	358,292	392,550	449,933	382,019	322,830
Idaho	94,700	100,270	106,992	117,011	106,102	94,950
Illinois	1,331,506	1,419,723	1,509,632	1,637,445	1,415,704	1,139,400
Indiana	631,342	670,870	721,360	821,703	741,625	656,210
Iowa	528,091	550,333	572,755	612,269	543,939	476,860
Kansas	468,810	476,833	501,593	540,622	487,206	434,660
Kentucky	256,517	274,901	292,095	333,417	281,314	232,100
Louisiana	247,370	261,240	278,339	343,508	301,619	265,860
Maine	144,866	150,137	157,361	173,811	133,895	109,720
Maryland	271,956	291,666	314,606	365,521	313,434	261,640
Massachusetts	690,185	721,115	747,204	804,496	607,089	472,840
Michigan	1,053,961	1,153,117	1,259,108	1,392,274	1,201,730	955,830
Minnesota	529,731	550,677	582,155	608,213	547,244	434,680
Mississippi	193,860	209,493	219,202	258,833	255,327	225,770
Missouri	608,554	654,770	698,181	775,837	644,095	514,840
Montana	117,604	126,521	137,591	148,387	126,907	109,720
Nebraska	225,442	235,489	236,437	251,545	234,926	211,000
Nevada	38,665	43,880	43,799	46,283	48,721	37,980
New Hampshire	85,156	92,578	95,827	108,455	77,575	52,750
New Jersey	829,424	872,656	924,961	1,001,201	808,128	639,330
New Mexico	96,362	101,946	110,465	122,194	98,647	97,060
New York	1,802,216	1,900,716	1,970,554	2,049,453	1,585,338	1,221,690
North Carolina	400,949	429,606	459,409	542,774	425,540	371,360
North Dakota	127,298	131,739	152,784	165,782	164,996	156,140
Ohio	1,278,825	1,371,266	1,470,921	1,639,314	1,472,565	1,215,360
Oklahoma	408,730	426,667	444,507	477,436	422,800	419,890
Oregon	229,684	244,677	262,512	303,646	279,815	248,980
Pennsylvania	1,403,587	1,482,426	1,581,974	1,704,947	1,389,068	1,031,790
Rhode Island	120,988	129,878	133,964	147,280	119,231	99,170
South Carolina	195,557	212,325	234,234	275,320	217,950	183,570
South Dakota	129,335	133,292	143,712	152,624	143,612	128,710
Tennessee	280,860	288,737	326,967	385,816	360,816	312,280
Texas	1,270,370	1,340,893	1,419,858	1,673,237	1,741,021	2,525,670
Utah	92,950	99,746	107,194	116,893	113,287	99,170
Vermont	64,324	68,018	70,807	75,189	53,859	40,090
Virginia	355,170	382,097	417,603	497,356	403,026	335,490
Washington	338,405	349,454	379,004	442,516	443,897	396,680
West Virginia	190,396	204,917	221,005	240,188	195,900	147,700
Wisconsin	542,464	566,724	590,070	636,223	571,435	455,760
Wyoming	61,844	68,011	70,060	79,049	61,767	50,640
Total	21,418,572	22,678,474	24,125,627	26,775,262	23,630,061	21,100,000
Per Cent change from previous year	....	+5.88	+6.38	+10.98	−11.75	−10.71

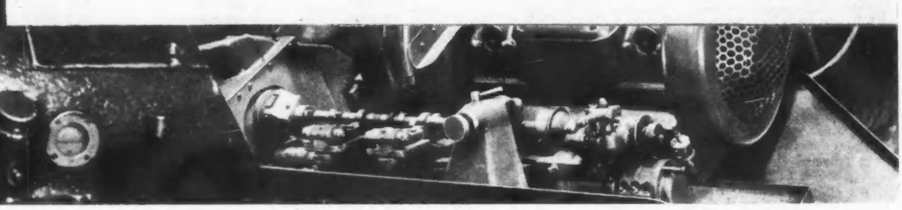
Source—American Petroleum Institute. †—Partly estimated by Automotive and Aviation Industries.

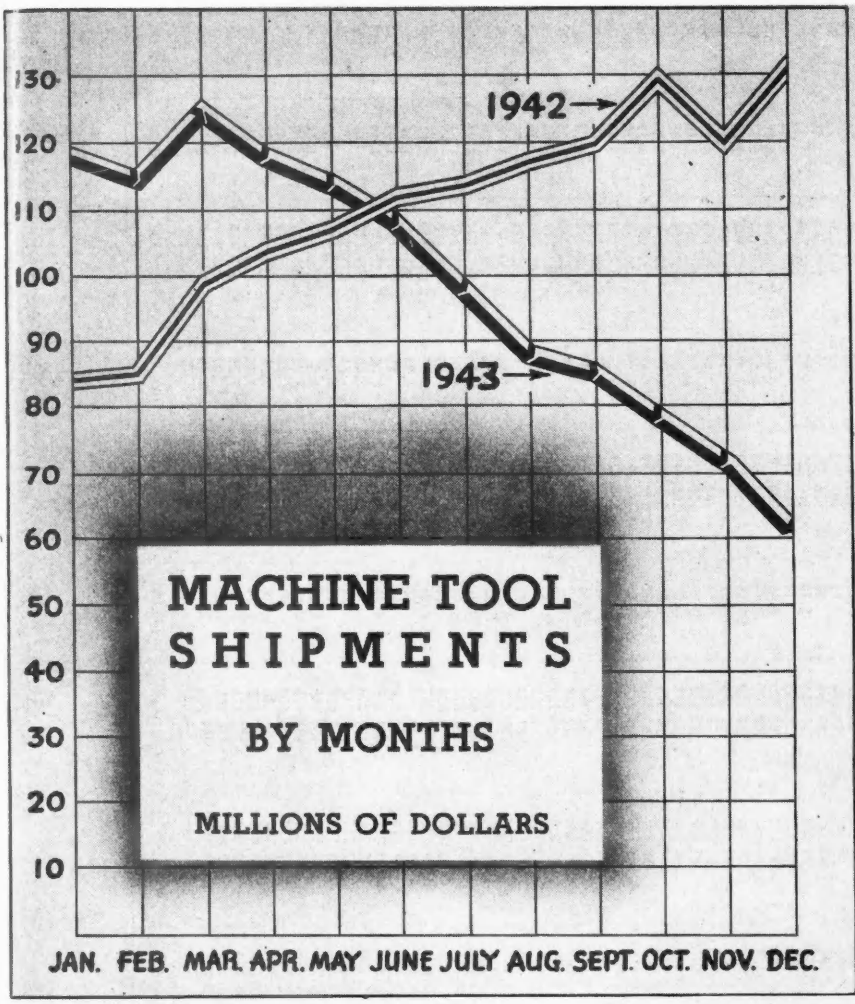


Yearly Dollar Volume of Machine Tool Shipments*

Year	Dollar Volume	Year	Dollar Volume
1920	$124,000,000	1932	$22,000,000
1921	23,000,000	1933	25,000,000
1922	46,700,000	1934	50,000,000
1923	82,000,000	1935	85,000,000
1924	57,400,000	1936	133,000,000
1925	91,500,000	1937	189,088,000
1926	105,000,000	1938	140,521,000
1927	87,000,000	1939	199,949,000
1928	128,000,000	1940	442,632,000
1929	185,000,000	1941	771,465,000
1930	96,000,000	1942	1,321,748,000
1931	51,000,000	1943	1,179,908,000

*—1920-1941 inclusive from reports of the National Machine Tool Builders Association. 1942 and 1943 data from W. P. B.

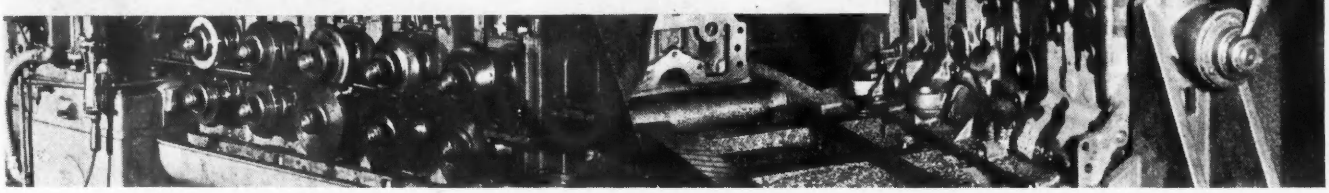




Monthly Dollar Volume of Machine Tool Shipments *

Months	1940	1941	1942	1943
January	$24,092,000	$50,725,000	$83,547,000	$117,384,000
February	27,836,000	54,705,000	84,432,000	114,593,000
March	28,887,000	57,400,000	98,358,000	125,445,000
April	31,145,000	60,300,000	103,364,000	118,024,000
May	32,846,000	60,800,000	107,297,000	113,859,000
June	34,614,000	63,400,000	111,090,000	108,736,000
July	31,468,000	57,900,000	113,596,000	97,541,000
August	40,870,000	64,300,000	117,342,000	87,805,000
September	42,321,000	68,700,000	119,883,000	85,842,000
October	49,455,000	77,200,000	130,008,000	78,302,000
November	46,423,000	74,600,000	120,871,000	71,543,000
December	52,675,000	81,435,000	131,960,000	60,834,000
Total	$442,632,000	$771,465,000	$1,321,748,000	$1,179,908,000

*—1940-1941 inclusive from reports of the National Machine Tool Builders Association. 1942 and 1943 data from the Tools Division of War Production Board.



What the States Individually Contribute to the National Economy

The latest prewar complete data pertaining to population density and the volume of business done in agriculture, manufacturing, wholesaling and retailing, showing frontiers for post-war development within the borders of the United States.

(All Dollar Volume data are in Thousands-of-Dollars)

STATE	POPULATION		FARM INCOME		MANUFACTURING				WHOLESALE TRADE		RETAIL TRADE		SERVICE ESTABLISHMENTS	
	1940	Per Square Mile 1940	Receipts from Sales 1940	Per Cent of U. S. Total Sales	Number of Establishments 1939	Value of Products 1939	Number of Employees 1939	Per Cent of U. S. Total Product Value	Value of Net Sales 1939	Per Cent of U. S. Total Sales	Value of Sales 1939	Per Cent of U. S. Total Sales	Receipts 1939	Per Cent of U. S. Total Receipts
Alabama	2,832,961	55.5	$87,000	1.04	2,052	$574,671	130,492	1.01	$415,688	.75	$435,973	1.04	$31,361	.92
Arizona	499,261	4.4	54,000	.64	332	97,529	8,255	.17	96,528	.17	162,003	.39	10,880	.32
Arkansas	1,949,387	37.0	139,000	1.66	1,178	160,167	41,857	.28	248,916	.45	298,301	.71	22,672	.66
California	6,907,387	44.1	649,000	7.75	12,329	2,798,180	362,609	4.92	3,840,129	6.95	3,187,809	7.58	328,141	9.60
Colorado	1,123,296	10.8	130,000	1.55	1,298	221,643	32,690	.39	435,126	.79	409,103	.97	27,473	.80
Connecticut	1,709,242	348.9	59,000	.70	2,936	1,229,586	282,099	2.16	413,134	.75	717,262	1.71	46,033	1.35
Delaware	266,505	134.7	28,000	.33	429	114,754	24,028	.20	157,474	.28	110,052	.26	6,758	.20
District of Columbia	663,091	......	......	......	497	79,875	14,753	.14	347,772	.63	402,768	.96	39,491	1.15
Florida	1,897,414	35.0	116,000	1.38	2,083	241,539	64,554	.42	525,889	.95	614,464	1.46	46,558	1.36
Georgia	3,123,723	53.4	143,000	1.71	3,150	677,403	179,161	1.19	806,238	1.46	624,765	1.49	45,057	1.32
Idaho	524,873	6.3	91,000	1.09	549	90,475	12,936	.16	105,510	.19	175,873	.42	8,630	.25
Illinois	7,897,241	141.2	543,000	6.48	12,980	4,794,861	759,710	8.45	4,998,766	9.04	2,857,646	6.80	294,956	8.63
Indiana	3,427,796	94.7	277,000	3.31	4,337	2,227,648	340,563	3.92	847,035	1.53	1,066,383	2.54	64,131	1.87
Iowa	2,538,268	45.3	669,000	7.98	2,670	718,532	88,789	1.26	790,518	1.43	822,905	1.96	47,727	1.40
Kansas	1,801,028	21.9	245,000	2.92	1,494	464,354	43,498	.82	427,651	.77	473,551	1.13	30,397	.89
Kentucky	2,845,627	70.9	151,000	1.80	1,640	481,030	76,887	.85	464,432	.84	520,135	1.24	34,093	1.00
Louisiana	2,363,880	52.3	94,000	1.12	1,861	565,265	88,723	.99	706,402	1.28	486,250	1.16	36,402	1.06
Maine	847,226	27.3	54,000	.64	1,210	345,369	83,978	.61	165,848	.30	281,356	.67	14,701	.43
Maryland	1,821,244	184.2	75,000	.90	2,893	1,027,354	166,931	1.81	688,939	1.25	619,273	1.47	45,218	1.32
Massachusetts	4,316,721	545.9	79,000	.94	9,007	2,459,711	552,310	4.32	2,232,117	4.04	1,737,680	4.13	138,433	4.06
Michigan	5,256,106	92.2	234,000	2.79	6,311	4,348,223	621,173	7.65	1,926,474	3.49	1,820,798	4.33	133,271	3.90
Minnesota	2,792,300	34.9	380,000	4.54	4,008	845,772	104,445	1.49	1,458,224	2.64	1,017,195	2.42	63,965	1.87
Mississippi	2,183,796	46.1	105,000	1.25	1,294	174,937	52,503	.31	245,154	.44	282,440	.67	20,834	.61
Missouri	3,784,664	54.6	275,000	3.28	4,796	1,388,056	223,467	2.44	2,261,256	4.09	1,102,503	2.62	98,936	2.89
Montana	559,456	3.8	97,000	1.16	585	151,885	12,440	.27	130,584	.24	222,008	.53	10,358	.30
Nebraska	1,315,834	17.2	223,000	2.66	1,161	273,525	26,739	.48	566,975	1.03	397,196	.94	26,372	.77
Nevada	110,247	1.0	14,000	.17	105	20,582	1,558	.04	23,249	.04	61,828	.15	3,348	.10
New Hampshire	491,524	54.5	23,000	.27	806	237,396	61,607	.42	64,263	.12	183,100	.44	9,429	.28
New Jersey	4,160,165	553.1	107,000	1.28	7,984	3,428,947	533,475	6.03	1,075,302	1.95	1,580,401	3.76	124,530	3.64
New Mexico	531,818	4.4	57,000	.68	272	25,124	4,147	.04	66,397	.12	125,765	.30	6,352	.19
New York	13,479,142	281.2	334,000	4.00	34,506	7,134,400	1,221,843	12.56	14,508,479	26.25	5,578,159	13.27	665,540	19.46
North Carolina	3,571,623	72.7	199,000	2.37	3,225	1,421,330	294,314	2.50	831,251	1.50	633,240	1.51	42,121	1.23
North Dakota	641,935	9.2	127,000	1.52	350	43,767	4,125	.08	170,252	.31	156,137	.37	6,643	.19
Ohio	6,907,612	168.0	324,000	3.87	10,070	4,584,666	735,277	8.06	2,630,784	4.76	2,441,293	5.81	175,094	5.12
Oklahoma	2,336,434	33.7	189,000	2.26	1,606	312,168	38,227	.55	461,519	.84	513,091	1.22	35,963	1.05
Oregon	1,089,684	11.3	110,000	1.31	2,248	365,374	74,396	.64	441,310	.80	442,160	1.05	34,203	1.00
Pennsylvania	9,900,180	219.8	273,000	3.26	13,801	5,475,925	1,021,636	9.63	3,347,488	6.06	3,133,377	7.44	213,100	6.23
Rhode Island	713,346	674.2	10,000	.12	1,460	516,391	122,886	.91	239,013	.43	275,447	.65	21,243	.62
South Carolina	1,899,804	62.1	99,000	1.18	1,331	397,513	136,713	.70	297,211	.54	332,224	.79	18,877	.55
South Dakota	642,961	8.4	120,000	1.43	468	81,172	7,485	.14	133,396	.24	169,396	.40	8,205	.24
Tennessee	2,915,841	69.5	127,000	1.52	2,289	728,088	153,166	1.28	839,529	1.52	606,489	1.44	44,037	1.29
Texas	6,414,824	24.3	510,000	6.09	5,376	1,530,221	166,438	2.69	2,040,548	3.69	1,803,716	4.29	137,198	4.01
Utah	550,310	6.7	46,000	.55	560	167,172	15,656	.29	194,172	.35	170,728	.41	11,416	.33
Vermont	359,231	38.7	42,000	.50	717	103,154	25,566	.18	57,112	.10	123,369	.29	5,982	.17
Virginia	2,667,773	67.1	123,000	1.47	2,579	988,813	152,255	1.74	627,632	1.14	628,172	1.49	44,230	1.29
Washington	1,736,191	25.9	144,000	1.72	3,240	636,650	108,834	1.12	767,731	1.39	668,790	1.59	53,510	1.56
West Virginia	1,901,974	79.0	40,000	.48	1,130	441,840	88,423	.78	284,196	.51	403,989	.96	19,662	.57
Wisconsin	3,137,587	57.3	311,000	3.72	6,717	1,604,507	254,625	2.83	824,956	1.49	1,064,994	2.53	62,421	1.82
Wyoming	250,742	2.6	51,000	.61	310	45,423	4,591	.08	37,031	.07	100,233	.24	4,467	.13
Totals	131,669,275	44.2	$8,379,000	100.00	184,230	$56,843,025	9,622,923	100.00	$55,265,640	100.00	$42,041,790	100.00	$3,420,417	100.00

SPECIFICATIONS SECTION

Cutting oil *News* letter

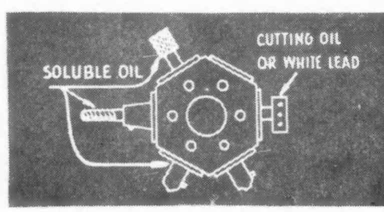
Practical suggestions from the field on how cutting oils and coolants are being used by midwest machine operators to lick tough wartime jobs.

MARCH, 1944

Machining time cut in half. An Indianapolis plant had trouble machining a rack without tearing or scratching the metal. This stainless steel rack had 65 teeth, .040 inch deep, of 64 pitch and ¼ inch face. Good results with ordinary oils were obtained only when the machine worked at slowest feed. Better results were obtained when carbon tetrachloride was added, but it made the operators sick. Stanicut 309 BCS was tried. Reports show it gave excellent results at faster speeds, cut the machining time in half, and had no ill effects on operators.

Three tips on better tapping. A big automotive plant in Michigan reports that Stanicut 155 CS was the complete answer to three tapping problems: 1. In a nut tapper Stanicut cleared up trouble in getting proper finish on Nickel-Molybdenum steel, giving better threads, lower oil consumption, and 80% longer tap life; 2. On thread rollers, using the same steel, Stanicut improved cooling, considerably extended die life; 3. On a tapper, Stanicut helped produce a perfect thread and made tools last longer, eliminating thread tearing and short die life in tapping a 2¾ inch packing nut (same steel).

One oil all around on turret lathe. Carboloy tools on a turret lathe required a soluble oil, but a threading



operation on the same lathe required a cutting oil to give reasonable die life. This meant swabbing the die with cutting oil, which then had to be cleaned from the bomb part being machined. At another plant, in machining steel bolts on a turret lathe, it was necessary to use white lead on the threading operation to get smooth threads, although soluble oil was needed for the other operations. Both plants switched to Stanicool H.D. Soluble Oil for both machining and threading at the suggestion of a Standard Oil Engineer. In both cases, threads improved and tool life was lengthened without sacrificing the cooling quality needed on the other operations.

Stanicool H.D.—a heavy duty, emulsifiable oil—will do many of the in-between jobs on which a cutting oil won't give adequate cooling, and a conventional soluble oil won't give the required finish or tool life.

No mixing . . . no mixup. A Michigan plant turning small rifle parts found that Stanicut 137 BCS gave much longer tool life than the base oil—paraffin oil mix formerly used. The use of Stanicut automatically eliminated a mixing operation and the chance of a mistake in mixing; and the use of one product simplified the jobs of ordering, stocking, and issuing.

When you bump up against special cutting oil problems

If you are running into trouble in handling war work, and find it tough to get the necessary accuracy, finish, and tool life on converted machines . . . or if you have other perplexing machining jobs that a more efficient application of cutting oils may help answer . . . call in a Standard Cutting Oil Specialist. Phone or write Standard Oil Company (Indiana) office, or 910 S. Michigan Ave., Chicago 5, Ill., for the Engineer nearest you. In Nebraska, contact any Standard Oil Company of Nebraska office.

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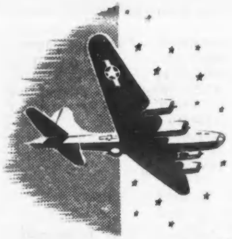
World Military Airplanes—*Grouped by Types*



World Military Airplanes—*Grouped by Types*

The following specifications of world military airplanes have been compiled from authoritative sources. The planes included are now in service although some few may not still be in production.

MAKE AND MODEL	TYPE	CREW	ARMAMENT	ENGINE: No. Used	ENGINE: Hp. per Motor	ENGINE: Make	DIMENSIONS: Span	DIMENSIONS: Length	DIMENSIONS: Height	DIMENSIONS: Wing Area (Sq. Ft.)	WEIGHTS: Empty	WEIGHTS: Loaded	PERFORMANCE: Maximum Speed at Altitude	PERFORMANCE: Range Miles at mph	PERFORMANCE: Initial Climb (fpm)	PERFORMANCE: Service Ceiling (ft)
BOMBERS—GERMAN																
Arado 81V3	Dive	2		1	610	Junkers	36′ 9″	28′ 6″	11′ 9½″	383.0	4,235	6,754	214 @ 13,120	430 @ 171		25,260
Arado 95	Torpedo	2	1-f-mc.g; 1-m-mc.g	1	845	BMW	41′ 0″	35′ 52″	12′ 9½″	480.7	4,983	7,260	185 @ 9,840	800 @ 162	1,640	26,000
Arado 95See	Torpedo-seaplane	3	1-f-mc.g; 1-m-mc.g	1	845	BMW	41′ 0″	36′ 5″	17′ 0″	480.7	5,390	7,854	170 @ 9,840	720 @ 142	1,321	23,944
Blohm und Voss Ha137A	Dive	1	4-f-mc.g, f.f; 1-250 kg. bomb	1	770	BMW	36′ 7″	31′ 0″	13′ 1″	252.8	3,800	5,300	211 @ 8,000	320 @ 185	2,100	23,000
Dornier 17Z2		4	6-m-mc.g	2	1000	Bramo	59′ 0″	52′ 5½″	15′ 9″	592.0	11,484	19,481	275 @ 16,400	745 @ 248		29,600
Dornier D0215		4	mc.g in nose, top & below cabin, f-a	2	1050	Daimler	59′ 1″	53′ 6″	15′ 9″	592.0	11,685	18,980	311 @ 16,400	965 @ 264	1,300	29,600
Dornier Do217(*)	Long range	4		2	1320	BMW	72′ 0″	63′ 5″		930.0	16,800	35,000†	294 @ 19,000	4,500 @ 200		
Dornier Do217E1	Reconnaissance	4	1-f-f, 15 mm. can; 4-m-mc.g	2	1600	BMW	62′ 6″	56′ 6″		620.0		33,500†	309 @ 19,100		638	
Dornier Do217E2	Multi-purpose	4	2-can; 7 mc.g	2	1495	BMW	62′ 5″	58′ 6″	12′ 6″	610.0	18,940	33,700	324 @ 18,500	1,500 @ 255	638	22,500
Focke-Wulf Fw200K2KurierII	Reconnaissance	5	2-cannon; 1-mc.g	4	1320	BMW	108′ 6″	78′ 3″	23′ 4″	1,290.0	28,700	44,100	279 @ 18,100	2,300 @ 226	940	28,850
Heinkel He46	Short range	2	1-f-mc.g, f.f; 1-gun, f-a		715	Siemens	46′ 8″	32′ 6″				6,420	147 @ SL	620 @ 119		
Heinkel He59	Multi-purpose	4	1-m-mc.g, f-f; 1-top mc.g; 1-mc.g. below	2	750	BMW	77′ 9″	57′ 1″	23′ 6″	1,649.0	13,673	19,800	137 @ SL	1,090 @ 109	680	11,240
Heinkel 111HaE	Torpedo	6	2-18 in. tar; 6-mc.g; 1-cannon	2	1150	DB	74′ 6″	53′ 7″	13′ 9″	942.0	16,000	27,400	254 @ 13,100	1,100 @ 215	800	24,100
Heinkel 111K2A		4	3-m-mc.g	2	1050	Mercedes	73′ 10″	57′ 5″	12′ 9″	942.0	12,828	27,247	252 @ 11,800	620 @ 214	840	22,000
Heinkel 111K5A		6	6-h-o, mc.g	1	1200	Junkers	74′ 3″	54′ 6″	13′ 9″	942.0	14,400	27,400†	274 @ 12,300	2,140 @ 230■	1,050	24,100
Heinkel He115	Floatplane	3	4-7.9 mm.g; 1-15 mm.g.	2	960	BMW	72′ 6″	56′ 8″	21′ 7″	942.0		20,000	208 @ 11,500			
Heinkel He170K1	Reconnaissance	2	1-f-mc.g, f-f; 2-m-mc.g	1	850	BMW	48′ 6″		10′ 1″	392.7						
Heinkel He170K2	Reconnaissance	2	1-f-mc.g, f-f; 2-m-mc.g	1	910	Mercedes	48′ 6″	39′ 4″	10′ 1″	392.7	5,647	9,163	248 @ 12,300	994 @ 236		24,600
Heinkel He177	Heavy	6	2-cannon; 2 or 3 mc.g	2	2300	Mercedes	103′ 4″	67′ 3″	18′ 2″	1,660.0	35,000	82,000†	280 @ 19,000	7,040 @ 180	840†	25,000
Heinkel He270K	Reconnaissance	2	1-f-mc.g. f-f; 2-m-mc.g	1	910	Mercedes	48′ 6″	39′ 0″	13′ 9″	392.7	5,874	9,427	273 @ 13,100	994 @ 267		29,520
Henchel Hs123A	Dive	1	2-f-mc.g: 1-bomb	1	880	BMW	34′ 5″	28′ 3″	9′ 0″	267.3	3,312	4,884	248 @ 9,200	530 @ 223	2,980	29,500
Henchel Hs123B	Dive	1	2-f-mc.g; 1-bomb	1	1000	Bramo	34′ 5″	28′ 3″	9′ 0″	267.3	3,516	4,950	262 @ 12,300			
Henchel Hs123C	Dive	1	2-f-mc.g; 1-bomb	1	1000	Bramo	34′ 5″	28′ 3″	9′ 0″	267.3	3,530	5,000	260 @ 12,300			
Henchel Hs129	Fighter		2-cannon; 4-mc.g	2	450	Argus						9,000	225 @ SL			
Junkers Ju52/3mK	General purpose	4	4-h-o-mc.g	3	660	BMW	95′ 11″	62′ 0″	14′ 10″	1,190.0	14,170	22,000	180 @ 5,500	700 @ 150		20,000
Junkers Ju86K	General purpose	4	3-h-o-mc.g	2	660	Junkers	73′ 10″	57′ 6″	15′ 8″	883.0	12,200	17,770	222 @ 1,000	1,200 @ 170		21,000
Junkers Ju86K1	General purpose	4	3-h-o-mc.g	2	660	Junkers	73′ 9″	58′ 8″	15′ 8″	882.3	11,354	17,770	224 @ 1,000	1,555 @ 174		21,300
Junkers Ju86K2	General purpose	4	3-h-o-mc.g	2	880	BMW	73′ 10″	59′ 0″	15′ 8″	883.0	11,308	18,040	239 @ 9,840	1,242 @ 205	820	24,380
Junkers Ju87A	Dive	2	1-f-mc.g; 1-m-mc.g	1	680	Junkers	45′ 4″	35′ 5″	13′ 11″	344.0	5,020	7,510	198 @ 12,000	620 @ 169	1,540	26,200
Junkers Ju87D	Dive	2	4-7.9 mm. mc.g.	1	1300	Jumo	45′ 4″	36′ 6″	13′ 0″	335.0		14,300	255 @ 13,500			
Junkers Ju88A1		4	4-m-mc.g	2	1200	Junkers	60′ 3½″	47′ 1″	15′ 5″	540.0	16,870	25,520	310 @ 15,500	960 @ 280(a)		29,800
Junkers Ju88A4		4	7-m-mc.g	2	1200	Junkers	65′ 0″	47′ 1″	15′ 5″				280 @ 15,500	870 @ 252		
Junkers Ju88A6		4		2	1450	Junkers	65′ 0″	47′ 1″	15′ 5″				300 @ 18,500	800 @ 254		
Junkers Ju288		4	Cannon	2	2000	Junkers							290 @ 19,000	800 @ 250		
Junkers Ju188		4	1-20 mm. can; 4-mc.g.	2	1530	B.M.W.	72′ 6″	49′ 0″		630.0			325 @ 20,000			
Messerschmitt Me410		2	2-20 mm. can; 4-mc.g.	2	1720	DBenz	54′ 0″			390.0		19,000	390 @ 22,000			
Messerschmitt Jaguar	Reconnaissance	4	4-f-mc.g; 2-m-cannon	2	1150	Mercedes	53′ 4″			414.0			320 @ 16,000			
Messerschmitt Me110	Fighter	2	2-f-can; 4-f-mc.g; 1-m-mc.g	2	1150	Mercedes	53′ 4″	40′ 9″	10′ 9″	414.0	9,900	15,290	365 @ 16,400	1,500 @ 215		35,000
Messerschmitt Me210	Long range	2	2-f-20 mm. can; 4-mc.g	2	1395	Mercedes	53′ 9″	40′ 3″	16′ 6″	355.0		25,150	365 @ 19,680	1,500 @ 275		
Messerschmitt Me-20A-1	Fighter	2	2-f-7.9 mm. mc.g; 4-can	2									375 @ 18,000			
BOMBERS—ITALIAN																
Breda Br88	Fighter	3	3-12.7 mm. feg; 2-7.7 mm; wings	2	1000	Piaggio	50′ 10″	37′ 9″		358.0		14,700	310 @ 13,500	1,450 @ 185†		28,500
Cant Z1007	Long Range	5	1-12.7mm, d-t; 1-12.7mm, ven; 2-7.7mm,lat	3	1000	Piaggio	81′ 4″	60′ 0″	18′ 6″	810.0	19,000	26,750	280 @ 15,000	800 @ 235		28,500
Cant Z1008	Medium			3	1000	Piaggio	81′ 4″	60′ 6″	17′ 1″			30,000	265 @ 13,000			
Cant Z506B	Reconnaissance	4	1-12.7 mm, d-t; 1-12.7 mm, ven	3	750	Alfa-Romeo	86′ 9″	62′ 0″	21′ 1″	936.0	18,040	27,100	230 @ 13,000	1,000 @ 195		24,000
Caproni Ca313	Reconnaissance	3		2	650	Isotto	53′ 6″	38′ 9″	14′ 4″			12,450	249 @			22,300
Caproni Ca316	Seaplane	3		2	450	Piaggio	53′ 2″	40′ 0″		416.0	7,270	10,250		990 @ 167		
Fiat B.G.A.	Heavy	5		2	1050	Fiat	70′ 6″	51′ 7″	15′ 10″			7,240	252 @			30,200
Fiat Br20		3	1-7.7 mm, feg; 1-12.7 mm, d-t; 1-7.7 mm. ven	2	1000	Fiat	70′ 9″	52′ 9″	14′ 0″	800.0		22,500	264 @ 13,000	1,240 @ 210		28,000
Piaggio P32	Long Range	4	1-7.7mm, feg; 2-12.7mm, d-t; 2-12.7mm, ven	2	1000	Piaggio						22,000	260 @ 15,000	1,100 @ 220		20,000
Piaggio P50	Heavy	6		4	1000	Piaggio	85′ 3″	65′ 7″	15′ 3″	1,067.0	26,500	42,000	280 @ 14,750	1,250 @ 250		25,000
Piaggio P108B	Transport	6		4	1300	Piaggio	108′ 3″	81′ 6″		1,539.0	33,000	59,000†	292 @ 11,480	2,500 @		26,000
Piaggio P123R		3		3	1000	Piaggio	95′ 5″	77′ 0″	16′ 4″	985.0	26,500	42,000	274 @ 14,750	2,380 @ 217		23,600
Savoia Marchetti SM79																
Savoia Marchetti SM84	Torpedo	5	4-12.7 mm. mc.g.	3	1000	Piaggio	69′ 4″	60′ 0″		648.0		27,700	290 @ 16,000			
Savoia Marchetti SM85	Dive	1		2	1000	Piaggio	52′ 6″	41′ 4″	13′ 3″	418.0			317 @ 13,100			

(continued on page 120)

World Military Airplanes—*continued*

MAKE AND MODEL	TYPE	CREW	ARMAMENT	ENGINE			DIMENSIONS				WEIGHTS (lb.)		PERFORMANCE			
				No. Used	Hp. per Engine	Make	Span	Length	Height	Wing Area (Sq. Ft.)	Empty	Loaded	Maximum Speed at Altitude	Range Miles at mph	Initial Climb (fpm)	Service Ceiling (ft)
BOMBERS—JAPANESE																
Aichi . . . LL-98	Reconnaissance	5	1-f-can; 4-f-mc.g; 1-m-can	3	770	Aichi	87′ 0″	63′ 0″	24′ 5″	940.0		26,800	230 @ 13,000	1,000 @ 199		24,000
Aichi . . . K-99	Dive, navy	2	2-f-mc.g, f-f; 1-m-mc.g, f-a	1		Aichi	48′ 0″	37′ 0″								
Fiat-Nichi . . . TB-98	Torpedo, army	5	3-m-mc.g	2	1030	Fiat	70′ 6″	52′ 10″	14′ 1″	796.0	14,300	22,220	268 @ 16,400	1,863 @ 214		29,520
Heinkel-Aichi . . . TB-98	Torpedo, army	6	6-m-mc.g	2	880	BMW	74′ 3″	54′ 6″	13′ 9″	942.0		16,764	239 @ 9,840	870 @ 192		
Kawasaki . . . LB-93	Reconnaissance	2	1-f-mc.g; 1-m-mc.g	1	600	Kawasaki	42′ 8″	32′ 9½″	9′ 10″			6,820	161 @ 1,000			22,960
Kawasaki . . . KB-97	Reconnaissance	2	2-f-mc.g; 1-m-mc.g	1	900	Kawasaki	47′ 8½″	32′ 8″	12′ 4″	295.0		7,000	236 @ 13,000	490 @ 206		25,000
Kawasaki . . . B-97	Army	5	2-m-can; 4-m-mc.g	2	820	Kawasaki	75′ 0″	62′ 0″	12′ 6″	665.0		20,900	245 @ 15,000	1,250 @ 196		24,500
Kawasaki . . . T97	Navy	10		4	900		131′ 0″	81′ 0″	20′ 6″	1900.0		45,000	215 @	1,500 @ 165		28,000
Mitsubishi . . . OB-93-1	Medium, army	5	2-m-mc.g	2	700	Mitsubishi	88′ 6″	49′ 2½″		979.0		17,820	136 @			
Mitsubishi . . . B-93	Medium, army	4	2-m-mc.g	2	450	Makajima	65′ 7″	42′ 7″		602.0		10,120	155 @			
Mitsubishi . . . B-96-1	Medium, navy	3		2	550	Makajima	55′ 0″						240 @	1,800 @		
Mitsubishi . . . H-96	Recon, navy	6	1-cannon; 4-mc.g	3	900	Mitsubishi	96′ 8″	70′ 0″	26′ 3″	2,500.0		38,750	145 @ 10,000	1,400 @ 125		13,000
Mitsub'shi . . . K-96	Dive, navy	2	2-f-mc.g; f-f; 1-m-mc.g, f-a	1	730	Mitsubishi	37′ 6″	30′ 9″	12′ 10″	420.0		5,200	200 @ 10,000			23,000
Mitsubishi . . . OB-96-4	Navy	4	6-mc.g	2	1000	Mitsobishi	82′ 0″	52′ 6″	12′ 4″	800.0		22,000	230 @ 10,000	1,615 @ 161		24,000
Mitsubishi . . . OB-96-4A	Navy	4	7-7.7 mm-mc.g	2	1000	Mitsubishi	82′ 0″	52′ 6″	12′ 4″	800.0		22,000	230 @ 10,000	1,615 @ 161		24,000
Mitsubishi . . . B-97Dεral	Medium, army			2			48′ 2″	30′ 5″	9′ 5″							
Mitsubishi . . . G-97-1	Torpedo, navy	2	1-f-mc.g, f-f; 2-m-mc.g, f-a	1	900	Mitsubishi	50′ 9″	33′ 11″	14′ 2″	375.0		8,500	195 @ 10,000	470 @ 167(1)		23,000
Mitsubishi . . . KB-97Karigane	Light, army	2	2-f-mc.g; f-f; 1 or 2-m-mc.g	1	550	Makajima	39′ 4″	26′ 11″	11′ 4″	215.0		5,750	310 @	1,490 @		
Mitsubishi . . . OB-97	Army	5	2-m-f-f; 2-m-d; 2-f-1; 1-f-t	2	870	Mitsubishi	72′ 2″	51′ 8″	11′ 11″	675.0	10,450	22,000	220 @ 10,000	2,480 @ 186		22,000
Mitsubishi . . . KB-98KariganeII	Light, army	2	2-f-mc.g, f-f; 1-m-mc.g, f-a	1	900	Mitsubishi	46′ 0″	28′ 2½″	11′ 9″	290.0		7,800	250 @ 11,000	280 @ 208		25,000
Mitsubishi . . . KB-98KariganeIII	Light, army	2	2-f-mc.g, f-f; 1-m-mc.g, f-a	1	900	Mitsubishi	46′ 0″	28′ 2½″	11′ 9″	290.0		7,800	250 @ 11,000	280 @ 208		25,000
Mitsubishi . . . OB-98	Heavy, army	4		2	750	Mitsubishi	75′ 0″	59′ 0″	13′ 1″	685.0		21,000	220 @ 15,000	1,180 @ 185		23,000
Mitsubishi . . . OB-01	Heavy, navy	8	4000 lb. bomb load	2	1050	Mitsubishi	80′ 0″	64′ 0″				26,000	270 @ 13,100	2,000 @		
Nakajima . . . T-94	Light, army	2	1-f-mc.g, f-f; 1-m-mc.g, f-a	1	550	Makajima	36′ 7″	24′ 5″	9′ 2″	322.5		5,720	186 @ 13,000	470 @ 150		23,000
Nakajima . . . G-96	Torpedo, navy	3	1-m-mc.g; f-a	1	600	Makajima	49′ 0″	33′ 0″	14′ 9″	540.0		7,300	168 @ 8,000	900 @ 145		20,000
Nakajima . . . G-97-2	Torpedo, navy	2	2-f-mc.g, f-f; 1 or 2-m-mc.g, f-a	1	700	Hikari	51′ 2″	34′ 6″								
Potez . . . B-01	Army	2	1-f-mc.g, f-f; 1-m-mc.g, f-a	2	670	Hispano-S	52′ 6″	36′ 3″	9′ 10″	355.0	6,085	9,680	279 @ 13,120	807 @		
BOMBERS—RUSSIAN*																
BB100	Dive															
DB-3F	Medium	4	3-mc.g.	2	1100	M-88	70′ 2″	47′ 6″				33,000	265 @ 16,000	2,500 @ 186		
DB-3(CKB-26)	Medium			2	1000								240 @	2,500 @		
IL-2(BSch)Stormovik	Dive		2-32 mm. can; 4-mc.g.	1	1300		43′ 0″						280 @			
PE-2	Light			2	1300		60′ 0″	45′ 6″	13′ 0″	592 .0			300 @			
SB-2	Medium			2	860		66′ 0″	40′ 8″					280 @ 12,800	750 @ 188		
SB-3	Medium			2	950		66′ 0″	41′ 6″					280 @	@ 217		
AR-2, SB-RK	Dive	3	3-mc.g.	2	1100	M-105	70′ 6″	40′ 0″				15,000	280 @	500 @ 217		25,000
Sukhan . . . SU-2(BB-1)	Light		2-f.mc.g; 1-mc.g.													
TB-6B	Heavy			4	1000											
YAK-4(BB-22)	Light			2	1100											
TB-7	Long range			4	1300	AM-38	120′ 0″						280 @ 25,000	2,500 @ (2)		
* Source—Aircraft Engineering who state: "These figures have been obtained from enemy sources and must not be taken as official."																
BOMBERS—BRITISH—4 Engine																
Avro . . . Lancaster I	Long range	6	10-.303 in. mc.g in 4 p-o-t	4	1280	Rolls-Royce	102′ 0″	69′ 4″	20′ 0″	1,297.0	35,000	63,000†	300 @	3,000 @		20,000
Avro . . . Lancaster II	Long range		10-.303 in. mc.g in 4 p-o-t	4	1600	Bristol-Her.	102′ 0″	69′ 4″	20′ 0″	1,297.0	35,000	63,000†	300 @	3,000 @		
Handley-Page . . . Halifax II	Long range	6	9-.303 in. mc.g, 13,000 lbs. bombs	4	1220	Rolls-Royce	98′ 0″	70′ 0″	20′ 9″	1,250.0	35,800	51,500	261 @ 19,500	3 000 @		
Short . . . Stirling	Long range	7	8-.303 in. mc.g in 3 p-o-t	4	1600	Bristol-Her.	99′ 1″	87′ 3″	22′ 9″	1,460.0	46,000	70,000	300 @	2,050 @ 227		
Short . . . Sunderland	Long range	11	7-.303 in. mcg, 2,000 lb. bombs	4	890	Bristol	112′ 9½″	85′ 4″	32′ 10½″	1,687.0	32,622	47,000	188 @ 6,500	2,900 @ 178†	720	20,500
BOMBERS—UNITED STATES—4 Engine																
Boeing . . . B-17F	Fortress			4												
Consolidated . . . B-24D	Liberator	9	10-50 caliber mc.g.	4	1200	Pratt & Whitney	110′ 0″	66′ 4″	17′ 11″	1048.0	34,933	56,000	320 @ O.A.	4,000 @ 230		36,000
Consolidated . . . PB2Y-3	Coronado	7		4	1200	Pratt & Whitney	115′ 0″	79′ 3″	27′ 6″	1780.0	39,332	66,000	217 @ 19,000	3,000 @ 160	700	20,800
BOMBERS—BRITISH—2 Engine																
Avro . . . Manchester	Heavy	6	8-.303 in. mc.g in 3 p-o-t	2	1845	Rolls-Royce	90′ 1″	68′ 10″	19′ 6″	1,131.0		56,000	300 @	2,000 @		
Blackburn . . . Botha	Torpedo	4		2	930	Bristol	59′ 0″	51′ 1½″	14′ 7½″	515.0						
Bristol . . . Beaufort	Torpedo	4	4-mc.g and bombs-1000 lb.	2	1130	Bristol	58′ 0″	44′ 7″	12′ 5″	503.0	11,910	17,030	270 @ 5,500	2,000 @		
Bristol . . . Blenheim IV		3	5-mc. g.	2	840	Bristol	56′ 4″	42′ 9″	9′ 2″	469.0	9,790	13,500	266 @ 11,800	1,900 @ 220	1,540	27,000
DeHaviland . . . Mosquito	Reconnaissance		4-20 mm. can; 4-.303 in. mc.g.	2		Rolls-Royce	54′ 2″	40′ 9″	15′ 3″	420.0						
DeHaviland . . . Mosquito IV		2	2000 lb. bomb load, unarmed	2		Rolls-Royce	54′ 2″	40′ 9″	17′ 3″	420.0						
Handley-Page . . . Hampden	Medium	4	6-.303 in. mc.g.	2	1000	Bristol	69′ 2″	53′ 7″	14′ 11″	737.0	12,764	19,150	254 @ 13,800	2,000 @ 217	980	22,700
Handley-Page . . . Hereford				2	980	Bristol										
Hawker-Siddeley . . . Whitley V	Heavy	5	5-.303 in. mc.g.	2	1130	Rolls-Royce	84′ 0″	69′ 3″	12′ 9″	1,232.0	19,200	27,900	222 @ 17,000	2,200 @ 210		26,000
Vickers . . . Wellington Ic	Long Range	6	2-mc.g.	2	965	Bristol	86′ 7″	64′ 7″	17′ 5″	840.0	15,887	28,500	250 @ 15,000	3,200 @ 180	1,120	24,000
Vickers . . . Wellington IV	Long range	6	6-.303 in. mc.g.	2	1100	Pratt-Whitney	86′ 2″	60′ 10″	18′ 9″	830.0	20,150	27,500	229 @ 13,000	3,200 @ 180		25,000

Vickers	Wellington IV	Long range	6	6-.303 in. mc.g.	2	1100	Pratt-Whitney	86' 2"	80' 10"	18' 9"	830.0	20,150	27,500	229 @ 13,000	3,200 @ 180		23,000

BOMBERS—UNITED STATES—2 Engine

Consolidated	PBY-5A	Catalina	5		2	1200	Pratt & Whitney	104' 0"	63' 10"	18' 10"	1,400.0	17,564	35,000	125 @ 10,000	2,520 @		15,800
Douglas	A-20C	Havoc	4	6-.30 cal. mc.g.	2	1600	Wright	61' 4"	47' 3"	18' 1"	464.1		20,000	352 @ 14,500	1,050 @ 280	2,000	25,300
Douglas	A-20G	Havoc	3	6-.50 cal. mc.g.	2	1600	Wright	61' 4"	47' 3"	18' 1"	464.1		20,000	352 @ 14,500	1,050 @ 280	2,000	25,300
Douglas	A-26		2	12-machine guns	2	1600	Wright	61' 4"	48' 0"	17' 6"	468.8	14,000	20,000	305 @ 13,000	1,000 @ 220		
Douglas	B-18A	Bolo			2	1200	Wright	90' 0"	56' 9"	15' 1"	987.0	17,800	26,000	225 @ 6,500	1,200 @ 182	1,050	25,000
Douglas	B-23	Dragon	6		2	1600	Wright	92' 0"	58' 5"	18' 5"	987.0	19,000	26,500	294 @ 13,250	1,455 @ 261	1,660	31,200
Lockheed	A-29	Hudson	4	7-machine guns	2	900	Wright	65' 6"	44' 3"	11' 10"	551.0	12,356	18,500	275 @ 15,000	2,160 @ 225	2,215	24,500
Lockheed	B-34	Ventura	4	8-machine guns	2	2000	Pratt & Whitney	65' 6"	52' 7"	11' 10"	551.0		22,500	300 @ 14,000	1,000 @ 260		25,000
Martin	PBM-2	Mariner	3		2	1600	Pratt & Whitney	118' 0"	77' 2"	17' 6"	1,330.0		40,000	250 @ 5,000	3,200 @ 165		17,000
Martin	B-26	Marauder	5	4-machine guns	2	2000	Pratt & Whitney	65' 0"	58' 2"	20' 0"	525.0		26,650	330 @ 15,000	2,400 @ 193		34,500
Martin	A-30	Baltimore	4	8-machine guns	2	1600	Wright	61' 4"	48' 6"	17' 9"	538.5			312 @ 6,000	1,200 @ 255		
North American	B-25C	Mitchell	5	6-.50 caliber mc.g.	2	1700	Wright	67' 7"	52' 10"	15' 9"	610.0	20,306	27,052	300 @			

BOMBERS—BRITISH—1 Engine

Blackburn	Skua	Dive	2		1	745	Bristol	46' 2"	35' 4¼"	12' 6"	312 0	5,847		225 @ 6,500	@ 187		20,200
Blackburn	Roc		2		1	905	Bristol	46' 0"	35' 7"	12' 1"							
Fairey	Albacore I	Reconnaissance	2	2-mc.g; 2000 lb. bomb load	1	1130	Taurus	50' 0"	39' 9"	14' 9"	623.0	7,250	10,460	161 @ 4,500			
Fairey	Battle	Reconnaissance			1	990	Rolls-Royce	54' 0"	52' 2"	15' 6"	422.0	6,647	10,792	257 @ 15,000	1,000 @ 200		25,000
Fairey	Fulmar	Reconnaissance		8-f-mc.g, f-f	1	1145	Rolls-Royce	46' 0"	40' 6"	14' 0"				284 @ 17,200			
Fairey	Sword Fish	Torpedo		1-f-mc.g, f-f; 1-mc.g, f-a	1	750	Bristol	45' 6"	40' 6"	12' 7"	549	5,300	81,10	128 @ 5,000	@ 131		19,250
Westland	Lysander	All purpose	2		1	905	Bristol	50' 0"	30' 6"	14' 6"	260.0	4,160	6,015				

BOMBERS—UNITED STATES—1 Engine

Brewster	SB2A-4	Buccaneer	2	8-.30 caliber mc.g.	1	1700	Wright	47' 0"	39' 2"	10' 10"		9,780	12,674	296 @ O.A.	1,680 @		28,000
Brewster		Bermuda	2	8-.30 caliber mc.g.	1	1600	Wright	47' 0"	39' 2"	10' 9"		9,518	12,782	297 @ O.A.	1,680 @		27,300
Curtiss	SBC-4	Cleveland	2	2-.30 cal. mc.g.	1	850	Wright	34' 0"	27' 5"	10' 3"	317.0	4,522	6,230	235 @ 15,000	855 @ 176		24,500
Curtiss	A-25; SB2C	Helldiver	2	5-machine guns	1		Wright										
Douglas	A-24; SBD	Dauntless	2	2-.50 cal; 2-.30 cal. mc.g.	1	1200	Wright	41' 6"	33' 1"	15' 7"	325.0	6,535	9,519	255 @ 14,000	456 @ 185		25,200
Douglas	TBD	Devastator	3		1	825	Pratt & Whitney	50' 0"	35' 6"	18' 1"			9,300	225 @ 9,000	985 @ 180		
Grumman	TBF-1	Avenger	3	5-machine guns	1	1700	Wright	53' 0"	37' 0"				12,000	270 @ 7,500	1,400 @ 215		20,000
Northrop Corp	A-17		2	5-machine guns	1	825	Pratt & Whitney	47' 10"	32' 5"	9' 9"	362.0	4,875	7,440	221 @ 9,000	800 @ 170	2,500	17,400
Northrop	N-3PB			4-.50 mc.g; 2-.30 mc.g.	1	1100	Wright	48' 11"	36' 0"	12' 0"	376.8	6,190	8,400	257 @	1,000 @		24,000
Vought-Sikorsky	SB2U-3	Vindicator	2	4-machine guns	1	750	Pratt & Whitney	42' 0"	33' 10"	9' 10"	305.3			257 @	700 @		28,200
Vultee	A-35	Vengeance	2	6-machine guns	1	1700	Wright	45' 0"	40' 0"	13' 0"				250 @	1,500 @		20,000

FIGHTERS—GERMAN

Arado	197	Shipboard	1	2-f-mc.g	1	880	BMW	36' 0"	30' 6"	10' 10"	293.7	3,610	4,600	220 @ 9,000			
Focke-Wulf	Fw159		1	2-f-mc.g, f-f	1	1000	Daimler										
Focke-Wulf	Fw187		2	2-can, f-f; 4-mc.g, f-f	2	1150	Daimler	50' 6"	33' 6"		300.0		12,000	362 @ 19,685		3,450	38,940
Focke-Wulf	Fw190		1	8-mc.g	1	1320	BMW	37' 0"					7,000	370 @ 19,000	525 @ 300		40,000
Focke-Wulf	Fw190A3		1	4-f-can; 2-f-mc.g	1	1600	BMW	34' 5"	29' 4"	12' 0"	203.0	6,240	8,500	375 @ 18,000	525 @ 275	3,000	37,000
Heinkel	He112B		1	2-mc.g; 2-can in wings	1	910	Mercedes	29' 10"	29' 6"	12' 1½"	183.0	4,120	5,740	352 @ 12,300	710 @ 280	2,755	31,000
Heinkel	He113		1	1-20 mm. can; 2 mc.g in wings	1	1360	Mercedes	30' 10"	26' 10"	8' 3"	156.0			380 @ 19,000			
Henschel	Hs129	Close-support	1	2-can; 4-mc.g	2	450	Argus	50' 0"	38' 0"				9,000	225 @ SL			
Junkers	Ju88B	Intruder	3		2	1200	Junkers	60' 3½"	49' 2"		540.0			321 @ 15,500	960 @ 280		
Messerschmitt	Me109E		1	2-mc.g; 2-cannons	1	1150	Mercedes	30' 3¼"	26' 8"	7' 5½"	176.5	4,180	5,520	345 @ 12,300	560 @ 248	3,100	36,000
Messerschmitt	Me109F		1	1-f-can; 2-f-mc.g	1	1085	Mercedes	32' 8"	29' 8"	8' 6"	173.0	4,740	6,090	371 @ 22,000	370 @ 307	3,200	40,000
Messerschmitt	Me109F2		1	1-f-15 mm. can; 2-f-mc.g	1	1150	Mercedes	32' 8"	29' 8"	8' 6"	173.0		6,090	375 @ 22,000		32,000	40,000
Messerschmitt	109G		1	2-7.9 mm; 3-20 mm. can.	1	1350	Mercedes	32' 7"	29' 9"	8' 6"	173.0		6,820	400 @ 22,000			
Messerschmitt	Me110																
Messerschmitt	Me110C5	Long range	2	2-f-can; 4-f-mc.g; 1-m-mc.g	2	1200	Mercedes	53' 4"	40' 9"	11' 6"	380.0		16,000	310 @			

FIGHTERS—ITALIAN

Breda	BA88		2	3-12.7 mm, fsg; 2-7.7 mm. in wings	2	1000	Piaggio	50' 8"	37' 8"		358.0		14,700	300 @ 15,000	900 @ 265		28,500
Caproni	Ca335 Maestrale	Escort	2		1												
Fiat	CR42	Biplane	1	1-7.7 mm, fsg; 1-12.7 mm	1	840	Fiat	32' 0"	27' 0"	10' 0"	237.0		5,100	270 @ 13,000	460 @ 232		31,000
Fiat	G50		1	2-12.7 mm, fsg; 2-7.7 mm. in wings		840	Fiat	35' 9"	25' 6"	8' 3"	196.0		5,200	300 @ 14,500	260 @ 250		32,000
Macchi	C200		1	2-12.7 mm, fsg; 2-7.7 mm in wings	1	840	Fiat	35' 0"	27' 0"	11' 6"	161.0		4,850	305 @ 15,000	280 @ 265		33,000
Macchi	C202		1	2-12.7 mm, fsg	1	1200		35' 0"	29' 0"	9' 11"	181.0		6,300	330 @ 18,000	@ 300		34,000
Meridionali	Ro43	Navy	2	1-7.7 mm, fsg; 1-7.7 mm	1	700	Piaggio						5,400	186 @ 8,000	440 @ 155		26,000
Reggiane	Re2001		1	2-12.7 mm.; 2-7.7 mm.mc.g.	1	1150	Daimler	36' 0"	27' 4"	12' 0"	220.0		7,000	350 @ 2,000			

FIGHTERS—JAPANESE

Kawasaki	I-95		1	3-f-mc.g, f-f	1	600	Kawasaki	33' 0"	28' 2½"	9' 10"	230.0		4,000	250 @ 13,000	300 @ 216		33,000
Kawasaki	S-98		1	2-f-can; 2-f-mc.g	1	820	Kawasaki	29' 0"	23' 0"	10' 2"	236.0		5,000	270 @ 10,000	400 @ 216		32,000
Messerschmitt	S-01	Army	1	2-f-can; 2-f-mc.g	1	1150	Mercedes	30' 3½"	28' 8"	7' 5½"	174.0	4,180	5,520	354 @ 12,300	561 @ 248		36,000
Messerschmitt	S-01	Navy	2	2-f-can; 4-f-mc.g; 1-m-mc.g	1	1200	Mercedes	53' 4"	40' 9"	11' 6"	380.0	9,900	15,290	350 @ 19,000	1,500 @ 215		32,000
Mitsubishi	S-96-2	Navy	1	2-7.7 mm, fsg; 2-7.7 nn-mc.g	1	730	Mitsubishi	36' 0"	24' 6"	9' 9"	170.0		4,300	250 @ 9,000	440 @ 217		31,000
Mitsubishi	S-97	Navy	1	2-7.7 mm, fsg	1	650	Mitsubishi	40' 0"	25' 0"		170.0		4,500	265 @ 11,000	590 @ 225		30,000
Mitsubishi	S-00	Navy	1	2-f-can, f-f; 2-f-mc.g, f-f	1	1100	Nakajima	39' 5"	28' 5"	9' 0"	256.0		5,140	315 @ 10,000	590 @ 265		36,000
Mitsobishi	S-001	Navy	1	2-20 mm. can; 2-77.mm. mc.g.	1	1050	Mitsubishi	39' 5"	30' 3"	9' 0"	256.0		5,140	345 @ 13,000	1,600 @ 160		36,000
Mitsubishi	S-002	Navy	1	2-20 mm. can; 2-7.7 mm. mc.g.	1	1050	Mitsubishi	35' 0"	30' 3"	9' 0"			5,100	350 @	1,650 @		
Mitsubishi	SHS-00	Floatplane	1	2-20 mm. can; 2-7.7 mm. mc.g.	1	1050	Mitsubishi	39' 5"	34' 6"	14' 0"	256.0		6,500	295 @			28,000
Nakajima	S-91	Army	1	2-f-mc.g, f-f	1	450	Nakajima	38' 0"	23' 11"	10' 2"	215.2		3,300	192 @ 9,840	372 @		28,000

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World Military Airplanes—*continued*

MAKE AND MODEL	TYPE	CREW	ARMAMENT	ENGINE No. Used	ENGINE Hp. per Engine	ENGINE Make	DIMENSIONS Span	DIMENSIONS Length	DIMENSIONS Height	DIMENSIONS Wing Area (Sq. Ft.)	WEIGHTS Empty	WEIGHTS Loaded	PERFORMANCE Maximum Speed at Altitude	PERFORMANCE Range Miles at mph	PERFORMANCE Initial Climb (fpm)	PERFORMANCE Service Ceiling (ft)
Nakajima........S-97	Army	1	2-f-mc.g, f-f	1	800	Hikari	36' 0"	24' 0"	8' 0"	140.0		4,400	270 @ 15,000	340 @ 234		33,000
Nakajima........S-97	Navy	1	3-f-mc.g, f-f	1	750	Nakajima	35' 6"	25' 7"	7' 0"	160.0		4,300	270 @ 15,000	460 @ 233		32,000
Nakajima........SKT-97	Navy	2	2-f-mc.g, f-f; 2-mc.g, f-a	1	750	Nakajima	36' 9½"	33' 6"	11' 5"	185.0		5,300	220 @ 13,000	320 @ 190		27,000
Nakajima........S-01	Army	1	2-12.7 mm. mc.g.	1	1050	Mitsubishi	37' 7"	28' 7"								
Seversky........S-98	Navy	2	2-f-mc.g, f-f; 1-m-mc.g, f-a	1	950	Pratt & Whitney	36' 0"	26' 10"	9' 9½"	225.0	4,446	6,022	315 @ 14,300	675 @ 285		30,000
Showa........SB-99	Army	2	2-f-can, f-f; 1-f-mc.g, f-f; 1-m-mc.g	1	850	Showa	50' 0"	37' 5½"	9' 11"	384.0	6,375	9,712	220 @ 6,800	950 @ 180		26,000
FIGHTERS—RUSSIAN																
I-16C Super Rata																
I-17(CKB-19)																
I-26				1	1100											
I-153 Chicka																
MIG-3				1	1200	AM-35A	37' 6"	31' 3"	10' 6"	240.0			360 @			
SU-2(BB-1)																
Lagg-3		1		1	1100	M-105P	31' 8"	29' 5"		188.0		7,056	350 @ 16,400	400 @ 279		29,500
FIGHTERS—BRITISH																
Bristol........Beaufighter		2	4-20 mm. can; 6-mc.g in wings	2	1425	Bristol	57' 10"	41' 4"	15' 10"	502.0	13,800	21,000	330 @ 14,000	1,500 @ 200	1,850	28,900
Bristol........Blenheim IVF		2	7-0.303 in. mc.g.	2	860	Bristol	56' 0"	42' 7"	9' 2"	464.0	9,240	13,800	260 @ 12,000			
DeHaviland........Mosquito II		2	4-.303 in. mc.g; 4-20 mm. can.	2	1250	Rolls-Royce	54' 2"	41' 2"		436.0		18,540				
Westland........Whirlwind			4-20 mm. cannon	2	865	Rolls-Royce	45' 0"	32' 0"	9' 6"	250.0	8,290	9,900	353 @ 16,350			
Boulton Paul........Defiant II		2	4-.303 in. mc.g.	1	1260	Rolls-Royce	39' 4"	35' 4"	11' 0"	250.0	6,244	7,900	300 @ 13,500			
Gloster........Sea Gladiator			4-mc.g	1	850	Bristol	32' 3"	27' 5"	10' 4"	323.0			255 @	500 @		32,800
Hawker........Hurricane IIC		1	4-20 mm. cannon	1	1260	Rolls-Royce	40' 0"	31' 6"	10' 6"	257.6	5,675	7,290	339 @ 13,000			35,000
Hawker........Tornado				1												
Hawker........Typhoon 1B		1	4-20 mm. can.	1	2400	Napier	41' 7"	31' 11"	14' 7"	560.2	5,067	6,236	369 @ 19,500			
Supermarine........Spitfire V5		1	2-20 mm. can; 4-mc.g.	1	1110	Rolls-Royce	36' 10"	29' 11"	10' 0"	242.0	4,332	5,750	374 @ 18,400		2,300	36,000
Supermarine........Spitfire IX		1	4-cannon; 4-mc.g.	1		Rolls-Royce	36' 10"	31' 0"	11' 5"	242.0			400 @			
FIGHTERS—UNITED STATES																
Bell........P-39	Airacobra	1														
Brewster........F2A-3	Buffalo	1	4-.50 caliber mc.g.	1	1200	Wright	35' 0"	26' 4"	9' 9"		4,813	6,416	322 @ O.A.	1,185 @		32,750
Brewster........F3A-1	Corsair	1	6-.50 caliber mc.g.	1	2000	Pratt & Whitney	41' 0"	33' 4"	15' 3"		8,789	11,089	400 @ O.A.	943 @		32,850
Chance Vought........F4U-1	Corsair	1	6-.50 caliber mc.g.	1	2000	Pratt & Whitney	41' 0"	33' 4"	16' 1"				400 @	1,500 @		35,000
Curtiss........36A	Mohawk	1	2-.50 cal., 2-.30 cal. mc.g.	1	1200	Pratt & Whitney	37' 3"	29' 0"	9' 6"	236.0	4,554	5,655	302 @ 14,000	677 @ 262	3,065	32,700
Curtiss........P-40C	Tomahawk	1	2-.50 cal., 4-.30 cal. mc.g.	1	1100	Allison	37' 3"	31' 8"	10' 8"	236.0	5,812	7,549	360 @ 15,000	631 @ 311	2,140	31,500
Curtiss........P-40D	Kittyhawk	1	4-.50 cal., mc.g.	1	1150	Allison	37' 3"	31' 8"	10' 9"	236.0	5,970	8,040	365 @ 14,000	585 @ 313	2,290	31,100
Curtiss........P-40F	Warhawk		6-.50 cal., mc.g.	1	1130	Rolls-Royce	37' 3"	31' 9"	10' 9"	236.0	6,605	8,523	375 @ 20,000	560 @ 307	2,250	31,600
Douglas........A-26		2	8-.303 in. mc.g.	2	1600	Wright	61' 3"	47' 0"	15' 9"	465.0		17,662	300 @			30,000
Douglas........(A-20) P-70		2	4-20 mm. cannon	2	1600	Wright	61' 4"	47' 7"	17' 7"		15,750	20,930	325 @ O.A.	800 @		25,000
Grumman........F4F-4	Wildcat	1	4-machine guns	1	1200	Pratt & Whitney	38' 0"	23' 10"	9' 2"	260.0			325 @ 15,500	1,150 @ 285	3,300	28,000
Grumman........F6F	Hellcat	1	6-.50 caliber mc.g.	1	2000	Pratt & Whitney	42.40'	33' 7"								
Lockheed........P-38	Lightning	1	4-.50 mc.g: 1-can.	2	1600	Allison	52' 0"	37' 10"	9' 10"	327.0		13,500	400 @	3,000 @	4,000	40,000+
North American........A-36	Mustang	1	6-.50 caliber mc.g.	1	1325	Allison	37' 0"	32' 3"	11' 9"	233.2	6,550	8,230	400 @			30,000
North American........P-51	Mustang	1	4-.50 caliber mc.g.	1	1520	Rolls-Royce	37' 3"	32' 2"	11' 9"	233.2	6,950	8,400	400 @			
Northrop........P-61	Black Widow															
Republic........P-43	Lancer															
Republic........P-47	Thunderbolt															
Vultee........P-66	Vanguard	1		1	1200	Pratt & Whitney	36' 0"	28' 0"	9' 0"				350 @			
RECONNAISSANCE—GERMAN																
Arado........196	Seaplane	2	2-cannon; 2-mc.g, f-f; 1-m-mc.g	1	920	Brama	49' 6"	38' 6"	16' 5"	408.0	6,580	8,200	193 @ 13,000	670 @ 158	980	23,000
Arado........198							48' 10"	38' 8½"	14' 0"	378.0						
Blohm und Voss........Ha138	Flying-boat	5	3-single gun turrets	3	600	Junkers	88' 7"	65' 3"	18' 10"	1,204.0	17,820	28,180	171 @ SL	1,490 @ 146	729	16,000
Blohm und Voss........Br138B	Flying-boat	5	2-single gun turrets; 1-mc.g, h-o	3	600	Junkers	88' 7"	65' 3"	19' 10"	1,104.0	17,820	28,180	171 @ SL	1,490 @ 146	729	16,000
Blohm und Voss........Ha139B	Float-plane	4	2-f-mc.g, f-f; m.mc.g, f-a	4	600	Junkers	96' 9"	64' 6"	15' 9"	1,399.0	22,902	38,610	202 @ SL	3,230 @ 168	656	14,100
Blohm und Voss........Ha140	Seaplane	3		2	880	BMW	68' 10"	57' 9"	20' 0"	941.0	13,880	18,700	193 @ 13,000	715 @ 180	850	23,000
Blohm und Voss........Bv141B		2	f-mc.g; f-f	1	1580	BMW	63' 0"	49' 0"				9,700	278 @ 17,000			
Dornier........Do18K1	Flying-boat	4	m-mc.g, f-f; midship turret	2	600	Junkers	77' 9"	63' 1"	17' 9"	1,054.5	12,285	22,000	161 @ 1,000	3,220 @ 140		14,760
Dornier........Do18K2	Flying-boat	5	1-mc.g, h-o; 1 turret	2	865	BMW	77' 9"	63' 1"	18' 0"	1,054.5	12,600	30,000	186 @ 7,200	2,700 @ 161	830	17,400
Dornier........Do24	Flying-boat	6	3-single gun turrets	3	760	BMW	88' 7"	72' 2"	17' 10"	1,162.0	17,000	29,770	195 @ 5,900	2,050 @ 161		17,390
Dornier........Do26K	Flying-boat	4	1-23 mm. can; 2-mc.g, h-o	4	600	Junkers	98' 6"	80' 6"	22' 6"	1,290.0			209 @ 1,000	5,100 @ 140		
Heinkel........He114	Float-plane	2	1-f-mc.g, f-f	1	830	BMW	44' 6"	39' 0"	16' 11"	455.0	5,940	7,656	193 @ 8,400	560 @ 143	1,090	15,750
Heinkel........He115K2	Mine-Laying	3	2-m-mc.g	2	850	BMW	72' 10"	56' 9"	21' 8"	941.5	13,530	20,790	217 @ 11,150	1,305 @ 186	728	21,320
Heinkel........He116P	High	4		4	270	Hirth	72' 2"	45' 0"	12' 5"	677.0	9,592	15,698	233 @ 9,840	2,795 @ 198	820	21,650
Junkers........Ju86P2	High	3		2	1000	Junkers	77' 0"	53' 0"	15' 8"			18,000	230 @			40,000
Messerschmitt........Me208	Liaison	4		1	270	Argus	34' 5"	27' 2"	7' 6¼"	172.2			197 @ SL	[illegible] @ 188		20,340

RECONNAISSANCE—ITALIAN

Cant	Z501	Flying-boat	5	4-7.7 mm. mc.g.	1	910	Isotta-Fraschini	73.8′	46.9′	14.5′	668.0		12,500	155 @ SL			
Caproni	Ca310		3	3-7.7 mm. mc.g.	2	460	Piaggio	53.1′	40.0′	11.5′	418.0		10,250	230 @ 13,000			
Caproni	Ca313				2	650	Isotto-Fra.							249 @			
Breda	75			No official data available	1												
Fiat	R.S.14	Seaplane	5	3-mc.g.	2	840	Fiat	64.2′	45.5′	17.7′	555.0		16,000	237 @ 13,000			

RECONNAISSANCE—JAPANESE

Aichi	LL-97	Float-plane	2	1-f-mc.g; 1-m-mc.g	1	770	Aichi	42′ 7″	32′ 6″	13′ 7″	430.0		5,630	180 @ 13,000	410 @ 155		
Consolidated	LL-98	Flying-boat	6	4-m-mc.g	2	1200	Pratt & Whitney	104′ 0″	65′ 1″	18′ 6″	1,400.0	14,538	27,080	190 @ 10,500	400 @ 130		25,700
Kawanishi	LL-90-2	Flying-boat	6	4-m-mc.g	3	825	Kawanishi	101′ 8″	72′ 2″				33,000	133 @ 9,840	1,600 @ 107		
Kawanishi	LL-91	Flying-boat	5	2-m-mc.g	2	600	Kawanishi	77′ 7″						139 @ 9,840	2,300 @ 111		
Kawanishi	LL-94	Float-plane	3	1-f-mc.g; 1-m-mc.g	2	600	Kawanishi	46′ 0″	34′ 0″	15′ 5″	530.0		6,100	140 @ 5,000	550 @ 120		18,000
Kawanishi	LL-97	Flying-boat	10		4	900	Mitsubishi	131′ 0″	81′ 0″	20′ 0″			45,000	215 @ 13,000	1,500 @ 165		28,000
Kawanishi	LL-97-2	Float-plane	2	1-f-mc.g; 1-m-mc.g	1	650	Kawanishi	45′ 6″	38′ 0″	13′ 9″	680.0		8,000	155 @ 7,000	450 @ 135		19,000
Kawanishi	LL-97-3	Flying-boat	4	6-m-mc.g	4	720	Liore	104′ 0″	69′ 5″	23′ 5″	1,410.0	21,560	32,912	208 @ 6,560	930 @ 158		
Mitsubishi	T-92	Army	2	1-f-mc.g; 1-m-mc.g	1	420	Mitsubishi	41′ 8″	17′ 10″	9′ 10″		3,960	5,500	137 @	526 @ 109		19,680
Nakajima	KT-90-2	Float-plane	2	1-f-mc.g, f-f; 1-m-mc.g	1	450	Nakajima	39′ 4″	29′ 6″				5,500	168 @			
Nakajima	KT-95	Float-plane	2	1-f-mc.g, f-f; 1-m-mc.g, f-a	1	660	Nakajima	36′ 1″	27′ 11″	13′ 1″	330.0		5,800	160 @ 11,000	500 @ 135		18,000
Sasebo	KT-00	Float-plane	2	4-mc.g.	1	1050	Mitsubishi	37′ 0″	32′ 4″								

RECONNAISSANCE and OBSERVATION—BRITISH

Avroe	Anson		4	2-.303 mc.g; 200 lb. bomb load	2	355	Cheetah	56′ 6″	42′ 2″	13′ 1″	410.0	5,512	7,955	184 @ 5,000			
Armstrong	Whitley VII		5	5-.303 ir. mc.g.	2	1130	Rolls-Royce	84′ 0″	69′ 3″	12′ 9″	1,232.0	19,605	28,000	195 @ 6,500			
Percival	Q6				2	205	D. H. Gipsey	46′ 8″	32′ 3″	9′ 9″		3,600	5,550	195 @ SL	700 @ 181	1,150	21,000
Percival	Vega Gul				1	205	D. H. Gipsey	39′ 6″	25′ 4″	7′ 4½″	197.0	1,740	3,250	174 @	660 @ 170		

RECONNAISSANCE and OBSERVATION—UNITED STATES

Aeronca	L-3	Grasshopper	2		1	65	Continental	35′ 10″	21′ 10″	9′ ¾″	169.0	761	1,200	87 @ SL	218 @ 79	404	10,000
Beech	F-2	Photographic	3		2	450	Pratt & Whitney	47′ 8″	34′ 3″	9′ 4″	349.0	5,096	7,500	223 @	735 @ 194	1,650	24,000
Curtiss	SO3C		2	3-.30 cal. mc.g.	1	500	Ranger	38′ 0″	35′ 0″	16′ 11″	294.0	4,925	6,370	191 @ 8,300	710 @ 112		
Curtiss	O-52	Owl	2	2-.30 cal. mc.g.	1	600	Pratt & Whitney	40′ 9″	26′ 5″	9′ 11″	210.0	4,216	5,349	215 @ 15,000	700 @ 195		21,000
Curtiss	SO3C	Seagull	2		1	450	Pratt & Whitney	38′ 10″	35′ 8″	16′ 7″	342.0			165 @	675 @		
Piper	L-4H	Grasshopper	2		1	65	Continental	35′ 2½″	22′ 3″	6′ 8″	187.5	740	1,220	87 @ SL	206 @ 75	450	9,800
Taylorcraft	L-2	Grasshopper	2		1	65	Continental	35′ 5″	22′ 9″	7′ 0″	180.0	863	1,325	97 @ SL	275 @ 92	480	13,000
Vought-Sikorsky	OS2U-1		2		1	450	Pratt & Whitney	35′ 11″	33′ 7″	14′ 8″	261.9	3,335	4,980	171 @ 5,000	908 @ 152		18,200
Vultee Vigilant	L-1		2		1	280	Lycoming	51′ 0″	34′ 0″	10′ 0″		2,591	3,322	133 @	@ 121	1,160	20,000
Vultee Sentinel	L-5		2		1	190	Lycoming	34′ 0″	24′ 0″	7′ 1″	155.0	1,472	2,158	129 @	735 @ 121	975	15,800

TRANSPORT—GERMAN

Ago	Ao192			6 pass	2	240	Hirth	45′ 0″	34′ 2″	11′ 9″	276.0	3,960	6,220	208 @ SL	650 @ 171		16,400
Blohm und Voss	Bv222				6	1000	BMW	150′ 0″	112′ 0″				100,000	109 @ 9,840			
DFS	230A1	Glider	1	9 pass. and freight				69′ 11″	37′ 0″	9′ 4″	410.0	1,700	4,500	100 @ 1,000			
Dornier	18E&F	Mail Carrier	4		2	560	Junkers	86′ 3″	63′ 1″	17′ 8″	1,196.5	12,760	24,200	155 @ SL	3,600 @ 137		18,370
Dornier	Do23	Bomber	4	3-mc.g, h-o	2	750	BMW	84′ 0″	61′ 7″	17′ 8″	1,163.0	12,320	20,240	162 @ 1,000	930 @ 130	886	13,776
Focke-Wulf	Fw189	Army	3	1-f-can, f-f; 4-f-mc.g, f-f; 1-mc.g, h-o	2	450	Argus	60′ 4″	39′ 4″		409.0	5,920	7,480	222 @ 8,500		1,640	27,550
Gotha		Glider		14 mc.g				72′ 0″	48′ 0″			1,800	4,500	100 @ SL			
Gotha	Go242	Glider	2	21 passengers and freight				79′ 0″	52′ 6″	11′ 4″	762.0	3,200	8,500				
Gotha	Go244		4	21 troops	2	700	Gnome-Rhone	79′ 0″	52′ 6″	11′ 4″	762.0		17,500	169 @ 10,000			
Heinkel	He70		2	4 passengers	1	660	BMW	48′ 7″	39′ 4″	10′ 2″	292.9	5,566	7,612	224 @ SL	560 @ 163	1,310	18,000
Heinkel	He111a		2	10 passengers	2	660	BMW	74′ 3″	56′ 2″	12′ 9″	947.0	12,120	17,350	213 @ SL	930 @ 186	1,090	
Henschel	Hs126	Army cooperation	2	1-f-mc.g, f-f; 1-m-mc.g	1	870	BMW	47′ 6¾″	35′ 7″	12′ 3½″	340.0	4,466	6,798	220 @ 9,840	680 @ 197	1,870	27,880
Junkers	F13	Communications	2	4-6 passengers	1	310	Junkers	58′ 3″	34′ 7″	11′ 6″	473.7	3,080	5,300	126 @ SL	400 @ 110		17,400
Junkers	W33	Communications	2	2-4 passengers	1	310	Junkers	58′ 3″	34′ 6″	11′ 7″	473.7	3,220	5,960	132 @ SL	400 @ 106	550	17,720
Junkers	W33W	Float-plane	2	2-4 passengers	1	310	Junkers	58′ 3″	35′ 9″	12′ 10″	473.7	3,930	5,950	118 @ SL	400 @ 93	470	15,400
Junkers	Ju52/3mW	Ambulance	2	15-17 passengers, 2-mc.g	3	660	BMW	95′ 11″	64′ 0″	17′ 9″	1,190.0	15,640	22,050	172 @ 3,000	710 @ 150	660	16,070
Junkers	Ju52/3mZ	Glider tug	3	12 chutists or 17 troopers	3	845	BMW	95′ 11″	62′ 0″	14′ 10″	1,190.0	16,320	27,550	207 @ 8,500	806 @ 185	1,020	22,250
Junkers	60		2	6 passengers	1	600	BMW	46′ 11″	38′ 10″	12′ 9″	377.0	4,460	6,850	173 @ 3,000	745 @ 148	888	17,000
Junkers	Ju90B		4	40 passengers	4	820	BMW	114′ 10″	86′ 3″	21′ 3″	1,980.0	35,200	50,600	216 @ 3,610	1,305 @ 185	890	18,040
Junkers	160		2	6 passengers	1	670	BMW	46′ 9″	39′ 4″	13′ 2″	377.0	6,105	7,810	211 @ 3,000	745 @ 180	885	17,710
Junkers	Ju290		4	Approx. 50 troops	4	1000	Fafnir	123′ 0″	86′ 3″	21′ 3″			55,000	250 @	1,300 @		20,000
Messerschmitt	Me108A	Communications	4		1	270	Aegus	34′ 5″	27′ 2″	7′ 6½″	172.2	1,887	3,087	196 @ SL	620 @ 187		20,340
Messerschmitt	Me323		5	100 troops; 18-7.9 mm. mc.g.	6	965	Gnome-Rhone	181′ 0″	93′ 6″	24′ 0″	2,700.0			170 @ SL	700 @ 100		
Siebel	Fh104A	Communications	5		2	280	Hirth	39′ 5″	31′ 1″	8′ 8″	240.0	3,550	5,180	220 @ SL	590 @ 198	1,312	20,000

TRANSPORT—ITALIAN

Savoi Marchetti	SM82			40 troops	3	860	Alfa-Romeo	97′ 6″	73′ 6″	18′ 0″	1,290.0	22,000	38,000	205 @ 7,000	2,480 @ 200		20,000
Savoi Marchetti	SM83				3	750	Alfa-Romeo	66′ 3″	53′ 2″	13′ 6″	646.0			276 @ 13,120	2,500 @ 248		16,400

World Military Airplanes—*concluded*

MAKE AND MODEL	TYPE	CREW	ARMAMENT	ENGINE: No. Used	ENGINE: Hp. per Engine	ENGINE: Make	DIMENSIONS: Span	DIMENSIONS: Length	DIMENSIONS: Height	DIMENSIONS: Wing Area (Sq. Ft.)	WEIGHTS: Empty	WEIGHTS: Loaded	PERFORMANCE: Maximum Speed at Altitude	PERFORMANCE: Range Miles at mph	PERFORMANCE: Initial Climb (fpm)	PERFORMANCE: Service Ceiling (ft)
TRANSPORT—JAPANESE																
Douglas DC-3		3	21 passengers	2	1000	Wright	95′ 0″	64′ 5½″	16′ 11″	987.0	16,398	25,200	219 @ 7,700	1,620 @ 196	1,200	21,900
Junkers MC-95		3	17 passengers	3	770	BMW	95′ 11″	62′ 0″	14′ 10″	1,190.0	12,550	23,200	189 @ 13,000	546 @ 160		19,000
Heinkel MC-98		4	8 passengers	4	270	Hirth	72′ 2″	44′ 11″	12′ 5½″	677.0	9,592	15,686	233 @ 9,840	2,795 @ 198		21,650
Lockheed 14(WG3)		3	12 passengers	2	820	Wright	65′ 6″	44′ 2½″	11′ 5½″	586.0	11,025	17,500	257 @ 9,300	1,705 @ 205		24,700
Mitsubishi Hinazura	Communications	1	8 passengers	2	240	Mitsubishi	52′ 4″	34′ 6″	9′ 6″	339.0	3,775	5,850	174 @			16,500
Mitsubishi MC-20 (Army Y-98)		2	11 passengers	2	850	Mitsubishi	74′ 0″	52′ 8″	16′ 0″	755.0	11,900	18,300	266 @	1,240 @ [illegible]		23,000
Mitsubishi Karigane II	Communications	2		1	800	Mitsubishi	39′ 4¾″	27′ 11″	11′ 6″	258.0		5,060	310 @ 10,000	1,490 @ 200		
Osaka RK-97	Cooperation	3					34′ 0″	25′ 9″	10′ 6″							
T.G.D. T.R.1		2	4 passengers	2	240	T.G.D.	47′ 11″	34′ 9″	9′ 0″	269.0	3,014	5,500	180 @	1,120 @ 155		19,980
Tatikawa	Ambulance	2	2 stretcher cases	1	130	Cirrus	32′ 9½″	25′ 10″	7′ 9½″	236.7	1,328	2,294	112 @ 1,000			
TRANSPORT—RUSSIAN																
PS-35(Ant-35)		2	9 passengers	3	300	M-26	77′ 10″	55′ 9″	15′ 10″	904.0	7,376	11,088	129 @	558 @ 106		12,500
PS-84		3	25 passengers	2	1100	Wright	95′ 0″	64′ 5½″	16′ 11″	987.0	16,398	25,200	219 @ 7,700	1,620 @ 196	1,200	21,900
PS-89																
U-2	Ambulance															
ANT-20bis(L-760)		10	64 passengers	6	1100	M-100	210′ 0″	108′ 0″	29′ 6″	5,228.0		103,000	186 @	1,864 @		
TRANSPORT—BRITISH																
Avro York			50 passengers	4	1260	Rolls-Royce	102′ 0″	78′ 0″								
DeHaviland Albatross				4	375	D. H. Gipsey	105′ 0″	71′ 6″	22′ 3″	1,078.0	21,230	29,500		@ 210	1,018	17,900
Bristol Bombay		4	24 passengers	2	890	Bristol	95′ 9″	69′ 2″	19′ 6″	1,340.0	13,800	20,000	192 @ 6,500	2,230 @ 160	750	25,000
DeHaviland Flamingo				2	930	Bristol	70′ 0″	50′ 7″	15′ 3″	651.0	12,020	17,600	239 @ 6,500	1,210 @ 200		20,900
DeHaviland 89				2	200	D. H. Gipsey	48′ 0″	34′ 6″	10′ 3″	336.0	3,230	5,550	157 @ SL	556 @ 132	867	
TRANSPORT—UNITED STATES																
Beech UC-43	Traveler	4		1	450	Pratt & Whitney	32′ 0″	26′ 1½″	8′ 0″	296.4	3,085	4,250	203 @ SL	525 @ 171	1,500	24,300
Beech C-45A		5		2	450	Pratt & Whitney	47′ 8″	34′ 3″	9′ 4″	349.0	5,056	7,500	223 @ SL	735 @ 194	1,650	24,000
Consolidated C-87	Liberator	5		4	1200	Pratt & Whitney	110′ 0″	66′ 4″	18′ 0″	1,048.0	31,330	60,000	300 @ O.A.	4,000 @ 200		31,000
Curtiss C-46	Commando	4		2	2000	Pratt & Whitney	108′ 0″	76′ 4″	24′ 8″	1360.0	29,483	45,000	267 @ 13,300	1,750 @ 195	850	26,900
Douglas C-47(R4D-1)	Skytrain	4	28 passengers	2	1200	Pratt & Whitney	95′ 0″	64′ 5″	16′ 11″	987.0	16,970	29,000	230 @ 8,500	2,125 @ 185		24,100
Douglas C-53(R4D-3)	Skytrooper	4	28 passengers	2	1200	Pratt & Whitney	95′ 0″	64′ 5″	16′ 11″	987.0	16,970	31,000	229 @ 8,500	2,125 @ 185	1,170	24,100
Douglas C-54(R5D-1)	Skymaster	4	26 passengers	2	1350	Pratt & Whitney	117′ 6″	93′ 10″	27′ 6″	1,462.0	23,600	66,000	285 @	4,300 @ 222	1,200	
Fairchild UC-61A	Forwarder			1	165	Warner	36′ 4″	23′ 10″	7′ 7″	193.3	1,732	2,801	110 @ SL	555 @ 104		11,400
Grumman J4F-2	Widgeon			2	200	Ranger	40′ 0″	31′ 0″	9′ 0″	245.0	3,100	4,500	165 @	775 @ 138		15,500
Grumman JRF-5	Goose			2	450	Pratt & Whitney	49′ 0″	38′ 3″	12′ 0″	375.0	5,500	8,000	200 @	1,000 @ 160		
Lockheed C-56, 60	Lodestar	3		2	1200	Wright	65′ 6″	49′ 10″	11′ 10″	551.0	12,075	18,500	263 @ 8,800		1,850	26,100
Lockheed C-69	Constellation	9		4	2200	Wright	123′ 0″	95′ 0″	18′ 8″	1,650.0	48,630	82,000	300 @ 25,000	4,000 @		35,000

ABBREVIATIONS:

*—These details are approximate and should be taken only as general indications

**—Details unknown but include retractable, electrically operated turret on top of fusilage

†—Overload 35,000 pounds

‡—14-cylinder radial motor with fully enclosed cowling

●—Maximum overload 27,400 pounds

■—Overload range 2,640 miles

§—Equipped for bombing

▼—Overload 82,000 pounds

(1)—Carrying a 1,760 lb. torpedo

(2)—With bomb load of 2 tons

(a)—With 5,750 pounds of bombs

Can—Cannon

Comm—Communications

f—Fixed

f-a—Firing aft

f-f—Firing forward

fpm—Feet per minute

fsg—Forward fuselage

g—Guns

h-o—Hand operated

(IL)—In line

kg—Kilogram

m—Movable

mc.g—Machine gun

mph—Miles per hour

O.A.—Optimum Altitude

pass.—Passengers

p-o-t—Power operated turret

Rad—Radial

Recon—Reconnaissance

sh.g—Shell gun

sg—Single gun

SL—Sea level

smc.g—Sub-machine gun

tg—Tommy-gun

tor—Torpedoes

AIRCRAFT STANDARDS

INDEXES

Arranged alphabetically below are the aircraft standards that have been adopted by the N.A.S.C. and the S.A.E. Following the title of each standard is the number by which it is designated.

NASC

Copies of the N.A.S.C. standards may be obtained from the National Aircraft Standards Committee, care, Aeronautical Chamber of Commerce of America, Shoreham Building, Washington 5, D. C.

A

Angles—Bulb, Extruded, 24S Aluminum Alloy NAS132
Angles—Equal Legs, Extruded, 34S Aluminum Alloy NAS130
Angles—Unequal Legs, Extruded, 24S Aluminum Alloy.... NAS131
Angles — Equal Legs, Rolled From Aluminum Alloy NAS180

B

Bolts—Close Tolerance, Nickel Steel (2330)
- No. 10-32 .... NAS53
- ¼-28 .... NAS54
- 5/16-24 .... NAS55
- ⅜-24 .... NAS56
- 7/16-20 .... NAS57
- ½-20 .... NAS58
- 9/16-18 .... NAS59
- ⅝-18 .... NAS60
- ¾-16 .... NAS62
- ⅞-14 .... NAS64
- 1-14 .... NAS66

Bolts — Internal Wrenching, Steel, Min. Elong. 12%, H.T. 160,000 to 180,000 PSI
- ¼-28 .... NAS144
- 5/16-24 .... NAS145
- ⅜-24 .... NAS146
- 7/16-20 .... NAS147
- ½-20 .... NAS148
- 9/16-18 .... NAS149
- ⅝-18 .... NAS150
- ¾-16 .... NAS152
- ⅞-14 .... NAS154
- 1-14 .... NAS156
- 1⅛-12 .... NAS158

Bolt—Tank Strap, Adjustment NAS28
Bushings—Clamp-Up, Bronze. NAS74
Bushings — Clamp-Up, Steel, Cadmium Plated NAS73
Bushings — Clamp-Up, Steel, Chromium Plated NAS72
Bushings — Plain, Press - Fit, Bronze NAS76
Bushings — Plain, Press - Fit, Steel, Cadmium Plated...... NAS75
Button—Control Knob, ½ Diameter, Luminous Letter.... NAS127

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★ ★ ★ ★ ★

SAE

Copies of the S.A.E. standards may be had from the Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.

A

Altitude Graphs .... AS 1

B

Bending Radius, Tube..... AS 130
Bolt Heads, Hexagon—Aircraft Engine .... AS 30
Bolt Heads, Hexagon—Large Fillet .... AS 134

C

Cap, Thread Protector — Single and Dual Propeller Shafts .... *AS 42
Carburetor Control Connections—Size ¼, 5/16 and ⅜ .... AS 56
Carburetor Envelope, Aircraft—Size 48 .... ARP 57A
Carburetor Envelope, Aircraft—Size 58 .... ARP 58A
Carburetor Envelope, Aircraft—Size 78 .... ARP 59A
Carburetor Envelope, Aircraft—Size 100 .... ARP 60A
Carburetor Flange, Aircraft, 2 Bolt, Single Barrel No. 3 & 4 .... AS 62
Carburetor Flange, Aircraft, 4 Bolt, Single Barrel No. 2, 3, 4, 5, 6, 7, & 9 AS 63
Carburetor Flange, Aircraft, Double Barrel — Size 12 and 16 .... AS 64
Carburetor Flange, Aircraft, Double Barrel — Size 24 .... AS 65
Carburetor Flange, Aircraft, Double Barrel — Size 24 (Remote Fuel Discharge Type) ...... AS 66
Carburetor Flange, Aircraft, Rectangular — No. 9 & Size 12 .... AS 67
Carburetor Flange, Aircraft, Rectangular—Size 24 and 30 .... AS 68
Carburetor Flange, Aircraft, Triple Barrel—Size 41 .... AS 69
Catalogs, Overhaul Tool, For Aircraft Engines... AS 80
Catalogs, Spare Parts, For Aircraft Engines ...... AS 79
Cones, Front, Propeller Hub AS 92
Cones, Rear, Propeller Hub AS 93
Cotter Pins, Stainless Steel —Aircraft Engine ..... AS 39

D

Definitions, Aircraft Engine AS 20
De-Icer, Attachment Assemblies (Inflatable) ... AS 73
Dowel Pins .... AS 40

E

Envelope, Transparent, Moisture-Resistant ..... AS 6
Equipment, Spray, Corrosion - Preventive Compound .... AS 11

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AMERICAN AIRCRAFT ENGINES

ENGINE MAKE AND MODEL	A. T. C. Number	Arrangement	Cooling Medium	CYLINDER DATA: Number of Cylinders	Bore and Stroke (In.)	Total Piston Displacement (Cu. In.)	Compression Ratio (to 1)	B.M.E.P. at Cruising Hp. (Lb. per Sq. In.)	Blower Ratio	Cylinder Material	No. of Valves per Cylinder: Intake	Exhaust	Valve Arrangement	RATINGS: Maximum (Except Take-off): Horsepower	R. P. M.	At Sea Level or Altitude (Ft.)	Take-off: Horsepower	R. P. M.	Cruising: Horsepower	R. P. M.	Octane Rating of Fuel Required	Propeller Drive	Weight (Lb.): Engine—Dry Without Hub or Starter	Per Cruising Hp.	Carburetor—Number and Make Fitted	Ignition System: Make	Current Source	Number	Starting: Make	Method	Installation Dimensions Overall—Ins.: Length	Height or O. D.	Width	Height Above Engine Bed (In.)	Diam. Mount, Ring or Distance Between Bearers
Allison.......F4R	......	V60	Liq	12	5½x6	1710.0	6.65	152	8.80	8	2	2	OH	1000	2600	10800	1325	3000	750	2280	100	G	1345	1.79	1-Str	Scin	Mag	1	Ecl	EM	85⅞	36¾	29 9/32	23 9/32	18⅜
Allison.......F10R, F10L	......	V60	Liq	12	5½x6	1710.0	6.65	167	7.48	8	2	2	OH	1100	2600	††	1325	3000	825	2280	100	G	1345	1.63	1-Str	Scin	Mag	1	Ecl	EM	85⅝	36¾	29 9/32	23 9/32	18⅜
Allison.......F20R	......	V60	Liq	12	5½x6	1710.0	6.65	152	9.60	8	2	2	OH	1000	2600	14000	1200	3000	750	2280	100	G	1352	1.80	1-Str	Scin	Mag	1	Ecl	EM	85⅞	36¾	29 9/32	23 9/32	18⅜
Allison.......F21R	......	V60	Liq	12	5½x6	1710.0	6.65	167	7.48	8	2	2	OH	1100	2600	2500	1325	3000	825	2280	100	G	1353	1.64	1-Str	Scin	Mag	1	Ecl	EM	85⅞	36 21/32	29 9/32	23 9/32	18⅜
Allison.......E18	......	V60	Liq	12	5½x6	1710.0	6.65	152	9.60	8	2	2	OH	1000	2600	14000	1200	3000	750	2280	100	G	1435	1.91	1-Str	Scin	Mag	1	Ecl	EM	194	37 9/16	29 9/32	23 9/32	18⅜
Allison.......E19	......	V60	Liq	12	5½x6	1710.0	6.65	152	9.60	8	2	2	OH	1000	2600	14000	1200	3000	750	2280	100	G	1445	1.91	1-Str	Scin	Mag	1	Ecl	EM	194	37 9/16	29 9/32	23 9/32	18⅜
Allison.......E11	......	V60	Liq	12	5½x6	1710.0	6.65	.....	‡8.10	8	2	2	OH	1000	2600	20000	1325	3000	750	2280	100	G	1620	2.16	1-Str	Scin	Mag	1	Ecl	EM	216	40 1/16	23 9/32	25 15/32	18⅜
Allison.......F17R, F17L	......	V60	Liq	12	5½x6	1710.0	6.65	.....	8.10	8	2	2	OH	1100	2600	††	1425	3000	825	2280	100	G	1350	1.64	1-Str	Scin	Mag	1	Ecl	EM	85⅞	33¾	23 9/32	23 9/32	18⅜
Allison.......F26	......	B60	Liq	12	5½x6	1710.0	6.65	.....	9.60	8	2	2	OH	1000	2600	14400	1200	3000	750	2280	100	G	1352	1.80	1-Str	Scin	Mag	1	Ecl	EM	85⅞	36¾	29 9/32	23 9/32	18⅜
Continental.......A50 Series 8	190	Hor	Air	4	3⅞x3⅝	171.0	5.40	108	No	5	1	1	I	50	1900	SL	50	1900	42	1800	65	D	170	4.05	1-Str°	Scin	Mag	2	......	......	30 11/32	22 9/16	31 11/16	......	....
Continental.......A50 Series 9	190	Hor	Air	4	3⅞x3⅝	171.0	5.40	108	No	5	1	1	I	50	1900	SL	50	1900	42	1800	65	D	176	4.19	1-Str°	Scin	Mag	2	Ecl*	EM	32 11/32	22 9/16	31 11/16	......	....
Continental.......A65 Series 8	205	Hor	Air	4	3⅞x3⅝	171.0	6.30	114	No	5	1	1	I	65	2300	SL	65	2300	53	2150	73	D	170	3.21	1-Str°	Scin	Mag	2	......	......	30 11/32	22 9/16	31 11/16	......	....
Continental.......A65 Series 9	205	Hor	Air	4	3⅞x3⅝	171.0	6.30	114	No	5	1	1	I	65	2300	SL	65	2300	53	2150	73	D	176	3.32	1-Str°	Scin	Mag	2	Ecl*	EM	32 11/32	22 9/16	31 11/16	......	....
Continental.......A75 Series 8	213	Hor	Air	4	3⅞x3⅝	171.0	6.30	119	No	5	1	1	I	75	2600	SL	75	2600	63	2450	73	D	170	2.70	1-Str°	Scin	Mag	2	......	......	30 11/32	22 9/16	31 11/16	......	....
Continental.......A75 Series 9	213	Hor	Air	4	3⅞x3⅝	171.0	6.30	119	No	5	1	1	I	75	2600	SL	75	2600	63	2450	73	D	176	2.79	1-Str°	Scin	Mag	2	Ecl*	EM	32 11/32	22 9/16	31 11/16		
Continental.......A80 Series 8	217	Hor	Air	4	3⅞x3⅝	171.0	7.50	117	No	5	1	1	I	80	2700	SL	80	2700	63	2500	80	D	170	2.70	1-Str°	Scin	Mag	2	......	......	30 11/32	22 9/16	31 11/16	......	....
Continental.......A80 Series 9	217	Hor	Air	4	3⅞x3⅝	171.0	7.50	117	No	5	1	1	I	80	2700	SL	80	2700	63	2500	80	D	176	2.79	1-Str°	Scin	Mag	2	Ecl*	EM	32 11/32	22 9/16	31 11/16	......	....
Continental.......W670 Series 6A	162	Rad	Air	7	5⅛x4⅝	668.0	5.40	106	No	5	1	1	I	220	2075	SL	220	2075	169	1900	65	D	480	2.84	1-Str	Scin	Mag (a)	2	Ecl*	EM	34 3/16	42¼	......		20
Continental.......W670 Series 6N	162	Rad	Air	7	5⅛x4⅝	668.0	5.40	105	No	5	1	1	I	220	2075	SL	220	2075	169	1900	73	D	486	2.88	1-Str	Scin	Mag	2	Ecl	EM	35⅝	42½	......		20
Continental.......W670 Series K	162	Rad	Air	7	5⅛x4⅝	668.0	5.40	109	No	5	1	1	I	225	2175	SL	225	2175	189	2050	65	D	480	2.54	1-Str	Scin	Mag (a)	2	Ecl*	EM	34 3/16	42¼	......	......	20
Continental.......W670 Series M	162	Rad	Air	7	5⅛x4⅝	668.0	6.10	116	No	5	1	1	I	240	2200	SL	240	2200	202	2075	80	D	490	2.43	1-Str	Scin	Mag (a)	2	Ecl*	EM	34 3/16	42¼	......	......	20
Continental.......C75 Series 8	......	Hor	Air	4	4 1/16x3⅝	188.0	6.30	130	No	5	1	1	I	75	2250	SL	75	2250	65	2100	73	D	188	2.88	1-Str	Scin	Mag	2	......	......	30 13/32	21½	31½	......	....
Continental.......A100	......	Hor	Air	6	3⅞x3⅝	256.0	6.30	130	No	5	1	1	I	100	2350	SL	100	2350	90	2150	73	D	280	2.83	1-Str	Scin	Mag	2	DR	EM	41⅝	21¾	31½	......	16 11/16
Continental.......C115	......	Hor	Air	6	4 1/16x3⅝	282.0	6.25	139	No	5	1	1	I	115	2350	SL	115	2350	106	2150	73	D	285	2.50	1-Str	Scin	Mag	2	DR	EM	41⅝	21¾	31½	......	16 11/16
Continental.......C140	......	Hor	Air	6	4 1/16x3⅝	282.0	6.25	138	No	5	1	1	I	140	2850	SL	140	2850	128	2600	73	G	284	2.22	1-Str	Scin	Mag	2	DR	EM	44	24¾	31½	......	16 11/16
Franklin (1).......4AC176-BA2	221	Hor	Air	4	4x3½	176.0	6.00	104	No.	4	1	1	I	65	2300	SL	65	2300	48¾	2100	73	D	182	3.74	1-MS	Eis	Mag	2	......	PS	28⅝	19 11/32	30¼	8 9/16	....
Franklin.......4AC199-D3	226	Hor	Air	4	4¼x3½	199.0	6.30	110	No	4	1	1	I	85	2500	SL	85	2500	63¾	2300	73	D	209	3.28	1-MS	Eis	Mag	2	Au	EM	30 11/16	24 9/16	30¼	13⅛	....
Franklin.......4AC199-E3	226	Hor	Air	4	4¼x3½	199.0	7.00	117	No	4	1	1	I	90	2500	SL	90	2500	67½	2300	80	D	209	3.10	1-MS	Eis	Mag	2	Au	EM	30 11/16	24 9/16	30¼	13⅛	....
Franklin.......6AC298-F3	225	Hor	Air	6	4¼x3½	298.0	7.00	113	No	4	1	1	I	130	2550	SL	130	2550	97½	2300	80	D	280	2.87	1-MS	Eis	Mag	2	Au	EM	24 9/16	30¼	13⅛	......	....
Franklin.......4AC-199-B2	226	Hor	Air	4	4¼x3½	199.0	6.00	133‡	No	4	1	1	I	65	1950	SL	65	1950	....	......	73	D	189	2.90‡	1-MS	Eis	Mag	2	......	PS	28⅝	19 11/32	30¼	8 9/16	10⅝ (k)
Franklin.......4AC-199-B3	226	Hor	Air	4	4¼x3½	199.0	6.00	133‡	No	4	1	1	I	65	1950	SL	65	1950	....	......	73	D	208	3.20‡	1-MS	Eis	Mag	2	Au	EM	30 11/16	24 9/16	30¼	13⅛	10⅝ (k)
Franklin.......4AC-199-E4	226	Hor	Air	4	4¼x3½	199.0	7.00	143‡	No	4	1	1	I	90	2500	SL	90	2500	....	......	80	D	226	2.54‡	1-MS	Eis	Mag	2	Au	EM	30 11/16	24 9/16	30¼	13⅛	10⅝ (k)
Franklin.......4ACG-199-H3	226	Hor	Air	4	4¼x3½	199.0	7.00	128‡	No	4	1	1	I	113	3500	SL	113	3500	....	......	80	G	236	2.09‡	1-MS	Eis	Mag	2	Au	EM	36¼	25 5/16	30¼	13⅛	10⅝ (k)
Franklin.......6ACG-298-H3	Pen	Hor	Air	6	4¼x3½	298.0	7.00	125‡	No	4	1	1	I	165	3500	SL	165	3500	....	......	80	G	329	1.93‡	2-MS	Scin	Mag	2	DR	EM	43 11/16	24 9/16	30¼	13⅛	10⅝ (n)
Franklin.......6ACG-298-P3	......	Hor	Air	6	4½x3½	298.0	7.00	137‡	.....	4	1	1	I	165	3200	SL	....	......	....	......	80	G	337	......	2-MS	Eis	Mag	2	DR	EM	43 11/16	24 9/16	30¼	13⅛	10⅝
Jacobs.......L-4M	121	Rad	Air	7	5¼x5	757.0	5.38	88	No	5	1	1	I	225	2000	SL	245	2200	160	1900	73	D	497	3.10	1-Str	Scin	Mag	2	Ecl	EM	37 15/32	43½	......	......	16½
Jacobs.......L-4MB	121	Rad	Air	7	5¼x5	757.0	5.38	88	No	5	1	1	I	225	2000	SL	245	2200	160	1900	73	D	495	3.09	1-Str	Scin	B.M.	(b)	Ecl	EM	37 15/32	43½	......	......	16½
Jacobs.......R-755-9, L4MBB	121	Rad	Air	7	5¼x5	757.0	5.40	88	No	5	1	1	I	225	2000	SL	245	2200	160	1900	73	D	513	3.21	1-Str	Scin	B.M.	(b)	Ecl	EM	39½	37 7/32	......	......	16½
Jacobs.......R-755-5, L4MA7	121	Rad	Air	7	5¼x5	757.0	5.38	88	No	5	1	1	I	225	2000	SL	245	2200	160	1900	73	D	500	3.12	1-Str	Scin	Mag	2	Ecl	EM	37 7/32	43½	......	......	16½
Jacobs.......L-6M	195	Rad	Air	7	5½x5½	914.0	6.00	96	No	5	1	1	I	300	2100	3700	330	2200	210	1900	80	D	557	2.65	1-Str	Scin	Mag	2	Ecl	EM	37 15/32	45⅜	......	......	16½
Jacobs.......R-915-5, R-915-7, L-6MB	195	Rad	Air	7	5½x5½	914.0	6.00	96	No	5	1	1	I	300	2100	SL	330	2200	210	1900	80	D	555	2.64	1-Str	Scin	B.M.	(b)	Ecl	EM	40⅛	45⅜	......	......	16½
Jacobs.......R-915-3, L-6MBA	195	Rad	Air	7	5½x5½	914.0	6.30	96	No	5	1	1	I	300	2100	SL	330	2200	210	1900	80	D	570	2.71	1-Str	Scin	B.M.	(b)	Ecl	EM	40 7/32	45⅜	......	......	16½
Ken-Royce (4).......5G	46	Rad	Air	5	4¼x3¾	266.0	6.00	119‡	No	5	1	1	I	90	2250	SL	....	......	....	......	73	D	228	2.51‡	1-Hol	BS	Mag	2	......	PS	23¾	33¼	......	......	17⅞
Ken-Royce (4).......7G	52	Rad	Air	7	4¼x3¾	372.0	6.00	115‡	No	5	1	1	I	120	2225	SL	....	......	....	......	73	D	300	2.50‡	1-Hol	Scin	Mag	2	......	PS	24½	33¼	......	......	17⅞
Kinner.......K-5	3	Rad	Air	5	4¼x5¼	372.0	5.10	99	No	5	1	1	I	100	1810	SL	100	1810	75	1610	73	D	304	4.05	1-SH	BS	Mag	2	Ecl	PE	33 1/32	45⅝	......	......	14
Kinner.......B-5, B-54	51	Rad	Air	5	4⅝x5¼	441.0	5.25	94	No	5	1	1	I	125	1925	SL	125	1925	90	1725	73	D	312	3.47	1-SH	BS	Mag	2	Ecl	PE	33 1/32	45⅝	......	......	14
Kinner.......R-5, Series 2	153	Rad	Air	5	5x5½	540.0	5.50	102	No	5	1	1	I	160	1850	SL	160	1850	115	1650	73	D	335	2.91	1-SH	BS	Mag	2	Ecl	PE	33 1/32	45⅝	......	......	14
Kinner.......R-55, R-56	153	Rad	Air	5	5x5½	540.0	5.50	102	No	5	1	1	I	160	1850	SL	160	1850	115	1650	73	D	(m)	3.00	1-SH	BS	Mag	2	Ecl	PE	33 1/32	45⅝	......	......	14
Kinner.......R-53	153	Rad	Air	5	5x5½	540.0	6.00	100	No	5	1	1	I	175	2100	SL	175	2100	130	1900	73	D	351	2.70	1-SH	BS	Mag	2	Ecl	PE	33⅜	45⅝	......	......	14

Lycoming (3)	O-145A2	199	Hor	Air	4-3⅝x3½	144.5	5.65	110	No	4	1	1	I	55	2300	SL	55	2300	42	2100	73	D	163	3.88	1-SM	SES	Mag	2			24⅝	20 13/32	29 9/16		10¼
Lycoming	O-145A3	199	Hor	Air	4-3⅝x3½	144.5	5.65	110	No	4	1	1	I	55	2300	SL	55	2300	42	2100	73	D	165	3.94	1-SM	SES	Mag	2	Ecl	EM	24⅝	22 13/32	29 9/16		10¼
Lycoming	O-145A4	199	Hor	Air	4-3⅝x3½	144.5	5.65	110	No	4	1	1	I	55	2300	SL	55	2300	42	2100	73	D	174	4.15	1-SM	SES	Mag	2	DR	EM	26	23	29 9/16		
Lycoming	O-145B2	210	Hor	Air	4-3⅝x3½	144.5	6.50	112	No	4	1	1	I	65	2550	SL	65	2550	47	2300	73	D	163	3.48	1-SM	SES	Mag	2			24⅝	20 13/32	29 9/16		10¼
Lycoming	O-145B3	210	Hor	Air	4-3⅝x3½	144.5	6.50	112	No	4	1	1	I	65	2550	SL	65	2550	47	2300	73	D	166	3.52	1-SM	SES	Mag	2	Ecl	EM	24⅝	22 13/32	29 9/16		10¼
Lycoming	O-145B4	210	Hor	Air	4-3⅝x3½	144.5	6.50	112	No	4	1	1	I	65	2550	SL	65	2550	47	2300	73	D	175	3.73	1-SM	SES	Mag	2	DR	EM	26	23	29 9/16		
Lycoming	O-145C2	210	Hor	Air	4-3⅝x3½	144.5	6.50	108	No	4	1	1	I	75	3100	SL	75	3100	55	2800	73	D	163	2.97	1-SM	SES	Mag	2			29.31	20 13/32	29 9/16		10¼
Lycoming	O-145C3	210	Hor	Air	4-3⅝x3½	144.5	6.50	108	No	4	1	1	I	75	3100	SL	75	3100	55	2800	73	D	166	3.02	1-SM	SES	Mag	2	Ecl	EM	24⅝	22 13/32	29 9/16		10¼
Lycoming	O-145C4	210	Hor	Air	4-3⅝x3½	144.5	6.50	108	No	4	1	1	I	75	3100	SL	75	3100	55	2800	73	D	175	3.18	1-SM	SES	Mag	2	DR	EM	26	23	29 9/16		
Lycoming	GO-145C2	210	Hor	Air	4-3⅝x3½	144.5	6.50	106	No	4	1	1	I	75	3200	SL	75	3200	56	2900	73	D	196	3.51	1-SM	SES	Mag	2			24⅝	20 13/32	29 9/16		10¼
Lycoming	GO-145C3	210	Hor	Air	4-3⅝x3½	144.5	6.50	106	No	4	1	1	I	75	3200	SL	75	3200	56	2900	73	D	199	3.55	1-SM	SES	Mag	2	Ecl	EM	29 9/16	22 43/64	29 9/16		10¼
Lycoming	GO-145C4	210	Hor	Air	4-3⅝x3½	144.5	6.50	106	No	4	1	1	I	75	3200	SL	75	3200	56	2900	73	G	208	3.72	1-SM	SES	Mag	2	DR	EM	30 11/16	23	29 9/16		
Lycoming	R680-B4D	108	Rad	Air	9-4⅝x4½	680.4	5.50	101	1.00	5	1	1	I	225	2100	SL			165	1900	73	G	492	2.98	1-Str	Scin	Mag	1	Ecl	EM	37 3/32				19¼
Lycoming	R680-E3A	202	Rad	Air	9-4⅝x4½	680.4	7.00	125	1.00	5	1	1	I	285	2200	SL	300	2300	215	2000	87	D	515	2.40	1-Str	Scin	Mag	1	Ecl	EM	37½				19¼
Lycoming	O-235	223	Hor	Air	4-4⅜x3⅞	233.3	6.25	111	No	5	1	1	I	100	2550	SL			75	2300	73	D	239	3.19	1-MS	Scin	Mag	2	Ecl	EM	30.09	25.19	32.32		
Lycoming	O-235A	223	Hor	Air	4-4⅜x3⅝	233.3	6.25	111	No	5	1	1	I	100	2550	SL			75	2300	73	D	268	3.58	1-MS	Scin	Mag	2	DR	EM	31.54	25.20	32.32		
Lycoming	O-290A	229	Hor	Ar	4-4⅞x3⅞	289.0	6.50	109	No	5	1	1	I	125	2600	SL			94	2350	73	D	281	2.93	1-MS	Scin	Mag	2	DR	EM	31.54	28.64	32.32		
Lycoming	O-350	227	Hor	Air	6-4⅜x3⅞	349.5	6.25	113	No	5	1	1	I	150	2500	SL	150	2500	113	2270	73	D	341	3.02	1-MS	Scin	Mag	2	Ecl	EM	45.48	28.04	32.32		
Lycoming	O-350A	227	Hor	Air	6-4⅜x3⅞	349.5	6.25	113	No	5	1	1	I	150	2500	SL	150	2500	113	2270	73	D	347	3.07	1-MS	Scin	Mag	2	DR	EM	46.47	28.54	32.32		
Lycoming	O-435A	228	Hor	Air	6-4⅞x3⅞	434.0	6.50	109	No	5	1	1	I	185	2450	SL			139	2325	73	D	384	2.77	1-MS	Scin	Mag	2	DR	EM	46.21	28.04	32.32		
Lycoming	O-435-B		Hor	Air	6-4⅞x3⅞	434.0	7.50	113	No	5	1	1	I	235	3000	SL			177	2720	100	D	373	2.11	1-MS	Scin	Mag	2	Ecl	EM	45.11	29.61	32.32		
Lycoming	O-435-C	228	Hor	Air	6-4⅞x3⅞	434.0	6.50	109	No	5	1	1	I	185	2450	SL			139	2325	73	D	352	2.53	1-MS	Scin	Mag	2	Ecl	EM	45.48	28.04	32.32		
Lycoming	O-290-B	229	Hor	Air	4-4⅞x3⅞	289.0	6.50	109	No	5	1	1	I	125	2600	SL	130	2800	94	2350	73	D	246	2.62	1-MS	Scin	Mag	2			30.09	28.64	32.32		
Lycoming	O-290-C	229	Hor	Air	4-4⅞x3⅞	289.0	6.50	109	No	5	1	1	I	125	2600	SL	130	2800	94	2350	73	D	238	2.53	1-MS	Scin	Mag	2			30.09	28.64	32.32		
Menasco-Super Pirate	D4	67	IV-L	Air	4-4¾x5⅛	363.0	5.50	98	No	5	1	1	I	125	2175	SL	125	2175	87	1930	73	D	300	3.45	1-Str	Eis	Mag	2	Ecl	HE	48 7/16	29¼	19 13/16	9 13/32	16⅝
Menasco-Super Pirate	D4-87	67	IV-L	Air	4-4¾x5⅛	363.0	6.00	98	No	5	1	1	I	125	2175	SL	134	2260	87	1930	80	D	310	3.56	1-Str	Eis	Mag	2	Ecl	HE	48 7/16	29¼	19 13/16	9 13/32	16⅝
Menasco-Pirate	C4S	134	IV-L	Air	4-4¾x5⅛	363.0	5.50	114	9.60	5	1	1	I	150	2260	3000	158	2260	105	2010	80	D	320	3.04	1-Str	Eis	Mag	2	Ecl	HE	49 11/16	28 9/16	19 7/16	9 13/32	16⅝
Menasco-Super Bucaneer	C6S4	197	IV-L	Air	6-4¾x5⅛	544.0	5.50	130	10.90	5	1	1	I	260	2300	7500	290	2400	182	2040	87	D	550	3.02	1-Str	BS	Mag	2	Ecl	EM	74¼	39 13/32	17¼	8 23/32	13½
Monsoon (5)	A	208	IV-L	Air	4-4.13x4.52	242.0	6.25	140	No	7	1	1	I	100	2285	SL	100	2285	90	2100	73	D	205	2.28	1-(c)	Scin	Mag	1	Ecl	EM	37¾	27	12.36	8.66	15.75
Pratt & Whitney-Wasp Junior R-985 Series:																																			
	T1B3		Rad	Air	9-5 3/16x5 3/16	985.0	6.0	120	10.0	5	1	1	I	450	2300		450	2300			91	D	668		1-Str	Scin	Mag	2	Opt	EM	42.44	46.13			
	SB3		Rad	Air	9-5 3/16x5 3/16	985.0	6.0	120	10.0	5	1	1	I	400	2200	5000	450	2300			91	D	668		1-Str	Scin	Mag	2	Opt	EM	42.44	46.13			
Pratt & Whitney-Wasp-R1340 Series:																																			
	S1H1		Rad	Air	9-5¾x5¾	1344.0	6.0	118	12.0	5	1	1	I	550	2200	8000	600	2250			91	D	864		1-Str	Scin	Mag	2	Opt	EM	43.00	51.81			
	S3H1		Rad	Air	9-5¾x5¾	1344.0	6.0	118	12.0	5	1	1	I	550	2200	5000	600	2250			91	D	864		1-Str	Scin	Mag	2	Opt	EM	43.00	51.81			
	S1H1-G		Rad	Air	9-5¾x5¾	1344.0	6.0	118	12.0	5	1	1	I	550	2200	8000	600	2250			91	G	930		1-Str	Scin	Mag	2	Opt	EM	47.80	51.81			
Pratt & Whitney-Twin Wasp-R1830 Series																																			
	S1C3-G		Rad	Air	14-5½x5½	1830.0	6.7	130		5	1	1	I	L1050	2550	7500	1200	2700			125	G	1438		1-Str	Scin	Mag	2	Opt	EM	61.67	48.19			
	S3C4-G		Rad	Air	14-5½x5½	1830.0	6.7	130		5	1	1	I	L1100	2550	6200	1200	2700			125	G	1460		1-Str	Scin	Mag	2	Opt	EM	63.48	48.19			
		(2-	Speed	Blo	wer Engine)									H1000	2550	15400																			
	S4C4-G		Rad	Air	14-5½x5½	1830.0	6.7	130		5	1	1	I	L1050	2550	7500	1200	2700			125	G	1460		1-Str	Scin	Mag	2	Opt	EM	63.48	48.19			
		(2-	Speed	Blo	wer Engine)									H900	2550	15400																			
Pratt & Whitney-Twin Wasp-R2000 Series					Data Restricted																														
Pratt & Whitney-Double Wasp	R2800		Rad	Air	18-5¾x6	2804.0											2000																		
Ranger	6-440C-2	216	IV-L	Air	6-4⅛x5½	441.0	6.00	102	No	5	1	1	OH	175	2450	SL	175	2450	130	2300	65	D	376	2.90	1-Str	Scin	Mag	2	Opt	Opt	52 23/32	30 11/32	20 5/32	11¼	
Ranger	6-440C-3	216	IV-L	Air	6-4⅛x5½	441.0	6.20	105	No	5	1	1	OH	180	2450	SL	180	2450	135	2300	73	D	376	2.79	1-Str	Scin	Mag	2	Opt	Opt	52 23/32	30 11/32	20 5/32	11¼	
Ranger	6-440C-4	216	IV-L	Air	6-4⅛x5½	441.0	6.80	113	No	5	1	1	OH	190	2450	SL	190	2450	145	2300	80	D	376	2.60	1-Str	Scin	Mag	2	Opt	Opt	52 23/32	30 11/32	20 5/32	11¼	
Ranger	6-440C-5	216	IV-L	Air	6-4⅛x5½	441.0	7.50	117	No	5	1	1	OH	200	2450	SL	200	2450	150	2300	87	D	376	2.51	1-SM	Scin	Mag	2	Opt	Opt	52 23/32	30 11/32	20 5/32	11¼	
Ranger	SVG-770C-1B		IV-V	Air	12-4x5⅛	773.0	6.50	127	9.5	5	1	1	OH	450	3000	12000	520	3150	340	2730	91	G	780	2.29	1-Str	Scin	Mag	1	Opt	Opt	68.95	34.13	32.44	14.68	
Rolls-Royce (6)	V-1650-3		Vee	Liq	12-5.4x6	1649.0	6.0		(d)	7	2	2	I	1490	3000	13750	1380	3000	1110	f2700	100	G	1673	1.51	1-Str	Pac	Mag	2	Ecl	EM	87.1	41.6	29.96	23.91	33.41
Rolls-Royce	38-BR		Vee	Liq	12-5.4x6	1649.0	6.0		(i)	7	2	2	I	1240	3000	11500	1400	3000	1080	c2650	100	G	1473	1.36	1-Str	Pac	Mag	2	Ecl	EM	76.9	42.7	29.96	21.99	33.41
Warner-Scarab	50	2	Rad	Air	7-4¼x4¼	422.0	5.20	114‡	No	5	1	1	I	125	2050	SL	125	2050	(e)		73	D	292	2.34‡	1-SH	Scin	Mag	2	Ecl	EM	13	36 9/16			17
Warner-Super Scarab	50A	104	Rad	Air	7-4⅝x4¼	499.0	5.55	113‡	No	5	1	1	I	145	2050	SL	145	2050	(e)		73	D	306	2.11‡	1-SH	Scin	Mag	2	Ecl	EM	13	36 9/16			17
Warner-Super Scarab	165	214	Rad	Air	7-4⅝x4¼	499.0	6.40	125‡	No	5	1	1	I	165	2100	SL	175	2250	(e)		73	D	338	1.93‡	1-SH	Scin	Mag	2	Ecl	EM	14	37¼			17½
Wright	Whirlwind R-760-ET	126	Rad	Air	7-5x5½	756.0	6.10	110	No	5	1	1	I	235	2000	SL			195	1850	73	D	540	2.77	1-Str	Scin	Mag	2	Opt	Opt	42 7/16	45			19¼
Wright	Whirlwind R-760-E1	94	Rad	Air	7-5x5½	756.0	6.10	118	7.05	5	1	1	I	285	2100	SL	300	2250	225	2000	73	D	570	2.54	1-Str	Scin	Mag	2	Opt	Opt	42.44	45			19¼
Wright	Whirlwind R-760-E2	155	Rad	Air	7-5x5½	756.0	6.30	118	9.17	5	1	1	I	320	2200	SL	300	2400	225	2000	91	D	570	2.54	1-Str	Scin	Mag	2	Opt	Opt	42.44	45			19¼
Wright	Whirlwind R-975-E1	87	Rad	Air	9-5x5½	973.0	6.10	121	7.80	5	1	1	I	365	2100	SL			290	1950	73	D	660	2.28	1-Str	Scin	Mag	2	Opt	Opt	42.44	45			23⅜
Wright	Whirlwind R-975-E3	125	Rad	Air	9-5x5½	973.0	6.30	132	10.15	5	1	1	I	420	2200	1400	450	2250	325	2000	91	D	675	2.08	1-Str	Scin	Mag	2	Opt	Opt	41 11/64	45			23⅜
Wright	Cyclone R-1820-F52	148	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	7.00	5	1	1	I	775	2100	5800	890	2200	550	1900	91	D	1000	1.82	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
Wright	Cyclone GR-1820-F52	148	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	7.00	5	1	1	1	760	2100	5800	875	2200	550	1900	91	G	1095	1.99	1-SH	Scin	Mag	2	OPT	OPT	47.81	54.12			23⅜
Wright	Cyclone R-1820-F53	149	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	8.31	5	1	1	I	745	2100	9600	785	2200	550	1900	91	D	1000	1.82	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
Wright	Cyclone GR-1820-F53	149	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	8.31	5	1	1	1	730	2100	9600	770	2200	550	1900	91	G	1095	1.99	1-SH	Scin	Mag	2	OPT	OPT	47.81	54.12			23⅜
Wright	Cyclone R-1820-F55	198	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	(g)	5	1	1	I	760	2100	5800	875	2200	550	1900	91	D	1012	1.84	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
		(2-	Speed	Blo	wer Engine)				10.00					675	2100	15300																			
Wright	Cyclone GR-1820-F55	198	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	7.14	5	1	1	1	760	2100	5800	875	2200	550	1900	91	G	1107	2.01	1-SH	Scin	Mag	2	OPT	OPT	47.81	54.12			23⅜
		(2-	Speed	Blo	wer Engine)				10.00					675	2100	15300																			
Wright	Cyclone R-1820-F56	159	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	8.83	5	1	1	I	755	2100	11300	785	2200	550	1900	91	D	1000	1.82	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
Wright	GR1820-F56	159	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	8.83	5	1	1	I	740	2100	11300	770	2200	550	1900	91	G	1095	1.48‡	SCH	Scin	Mag	2	Opt		47.81	54.12			23⅜

(continued on next page)

American Aircraft Engines—*Concluded*

Engine Make and Model	A. T. C. Number	Cylinder Data: Arrangement	Cooling Medium	Number of Cylinders – Bore and Stroke (In.)	Total Piston Displacement (Cu. In.)	Compression Ratio (to 1)	B.M.E.P. at Cruising Hp. (Lb. per Sq. In.)	Blower Ratio	Cylinder Material	No. of Valves per Cylinder: Intake	Exhaust	Valve Arrangement	Ratings: Maximum (Except Take-off): Horsepower	R. P. M.	At Sea Level or Altitude (Ft.)	Take-off: Horsepower	R. P. M.	Cruising: Horsepower	R. P. M.	Octane Rating of Fuel Required	Propeller Drive	Weight (Lb.): Engine—Dry Without Hub or Starter	Per Cruising Hp.	Carburetor—Number and Make Fitted	Ignition System: Make	Current Source	Number	Starting: Make	Method	Installation Dimensions Overall—Ins.: Length	Height or O. D.	Width	Height Above Engine Bed (In.)	Diam. Mount, Ring or Distance Between Bearers
Wright Cyclone R-1820-F62	148	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	7.00	5	1	1	I	760	2100	5800	900	2350	550	1900	91	D	1000	1.82	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
Wright GR1820-F62	148	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	7.00	5	1	1	I	760	2100	5800	900	2350	550	1900	91	G	1095	1.44‡	SCH	Scin	Mag	2	Opt		47.81	54.12	54.12		23⅜
	(2-	Speed	Blo	wer Engine)				10.00					675	2100	15300																			
Wright Cyclone R-1820-F65	198	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	(g)	5	1	1	I	760	2100	5800	900	2350	550	1900	91	D	1107	1.45‡	SCH	Scin	Mag	2	Opt		47.81	54.12	54.12		23⅜
Wright GR1820-F65	198	Rad	Air	9-6⅛x6⅞	1823.0	6.40	126	(g)	5	1	1	I	760	2100	5800	900	2350	550	1900	91	G	1012	1.84	1-SH	Scin	Mag	2	Opt	Opt	43.38	54.12			23⅜
Wright Cyclone R-1820-G2	157	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	7.00	5	1	1	I	850	2100	5800	1000	2200	600	1900	91	D	1103	1.84	1-SH	Scin	Mag	2	Opt	Opt	43¼	54¼			23⅜
Wright Cyclone GR-1820-G2	157	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	7.00	5	1	1	I	850	2100	5800	1000	2200	600	1900	91	G	1193	2.00	1-SH	Scin	Mag	2	OPT	OPT	47.75	54.25			23⅜
Wright Cyclone R-1820-G3	171	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	8.31	5	1	1	I	840	2100	8700	875	2200	600	1900	91	D	1103	1.84	1-SH	Scin	Mag	2	Opt	Opt	43¼	54¼			23⅜
Wright Cyclone GR-1820-G3	171	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	8.31	5	1	1	I	840	2100	8700	875	2200	600	1900	91	G	1193	2.00	1-SH	Scin	Mag	2	OPT	OPT	47.75	54.25			23⅜
Wright Cyclone R-1820-G3B	171	Rad	Air	9-6⅛x6⅞	1823.0	6.20	137	8.31	5	1	1	I	820	2100	8800	900	2350	600	1900	91	D	1103	1.84	1-SH	Scin	Mag	2	Opt	Opt	43¼	54¼			23⅜
Wright Cyclone GR-1820-G3B	171	Rad	Air	9-6⅛x6⅞	1823.0	6.20	137	8.31	5	1	1	I	820	2100	8800	900	2350	600	1900	91	G	1193	2.00	1-SH	Scin	Mag	2	OPT	OPT	47.75	54.25			23⅜
Wright Cyclone R-1820-G5	154	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	(g)	5	1	1	I	850	2100	6000	1000	2200	600	1900	91	D	1115	1.86	1-SH	Scin	Mag	2	Opt	Opt	43¼	54¼			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					750	2100	15200																			
Wright Cyclone GR-1820-G5	154	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	7.14	5	1	1	I	850	2100	6000	1000	2200	600	1900	91	G	1210	2.20	1-SH	Scin	Mag	2	OPT	OPT	47.75	54.25			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					750	2100	15200																			
Wright Cyclone R-1820-G5E	154	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	7.14	5	1	1	I	850	2100	6000	1000	2200	600	1900	91	D	1139	1.90	1-SH	Scin	Mag	2	OPT	OPT	43.25	54.25			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					750	2100	15200																			
Wright Cyclone GR-1820-G5E	154	Rad	Air	9-6⅛x6⅞	1823.0	6.45	137	7.14	5	1	1	I	850	2100	6000	1000	2200	600	1900	91	G	1234	2.60	1-SH	Scin	Mag	2	OPT	OPT	43.25	54.25			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					750	2100	15200																			
Wright Cyclone GR-1820-G102A	169	Rad	Air	9-6⅛x6⅞	1823.0	6.30	143	7.00	5	1	1	I	900	2300	6700	1100	2350	625	1900	91	G	1275	2.02	1-SH	Scin	Mag	2	Opt	Opt	48.12	55.10			23⅜
Wright Cyclone GR-1820-G103A	180	Rad	Air	9-6⅛x6⅞	1823.0	6.30	143	8.31	5	1	1	I	860	2300	11100	1000	2350	625	1900	91	G	1275	2.02	1-SH	Scin	Mag	2	Opt	Opt	48.12	55.10			23⅜
Wright Cyclone GR-1820-G105A	192	Rad	Air	9-6⅛x6⅞	1823.0	6.30	143	(g)	5	1	1	I	900	2300	6700	1100	2350	625	1900	91	G	1287	2.04	1-SH	Scin	Mag	2	Opt	Opt	48.12	55.10			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					775	2300	17300																			
Wright 718C9GB1	192	Rad	Air	9-6⅛x6⅞	1823.0	6.30	143	(o)	5	1	1	I	900	2300	6700	1100	2350	625	1900	91	G	1287	1.43‡	SH	Scin	Mag	2	Opt		48.12	55.10			23⅜
	(2-	Speed	Blo	wer Engine)				10.00					775	2300	17300																			
Wright Cyclone 702C9GC	219	Rad	Air	9-6⅛x6⅞	1823.0	6.70	152	7.00	5	1	1	I	1000	2300	6900	1200	2500	700	2000	91	G	1310	1.87	1-SH	Scin	Mag	2	Opt	Opt	50.04	55⅛			23⅜
Wright Cyclone GR-1820-G203A		Rad	Air	9-6⅛x6⅞	1823.0	6.70	141	8.30	5	1	1	I	950	2300	9100	1100	2500	650	2000	91	G	1310	2.01	1-SH	Scin	Mag	2	Opt	Opt	50.04	55⅛			23⅜
Wright Cyclone 704C9GC	219	Rad	Air	9-6⅛x6⅞	1823.0	6.70	152	7.14	5	1	1	I	L1000	2300	6900	1200	2500	700	2000	91	G	1320	1.89	1-SH	Scin	Mag	2	Opt	Opt	50.04	55⅛			23⅜
	(2-	Speed	Blo	wer Engine				10.00					H900	2300	15200																			
Wright 728C9GC	219	Rad	Air	9-6⅛x6⅞	1823.0	6.30	152	7.00	5	1	1	I	1000	2300	6000	1200	2500	700	2000	91	G	1310	1.31‡	SH	Scin	Mag	2	Opt		50.04	55⅛			23⅜
Wright 730C9GD1	219	Rad	Air	9-6⅛x6⅞	1823.0	6.20		7.00	5	1	1	I	1000	2300	6900	1200	2500	700	2000	91	G	1310		1-SH	Scin	Mag	2	Opt	Opt	50.04	55.10			23⅜
Wright Cyclone 579C14AC1	176	Rad	Air	14-6⅛x6 5/16	2603.0	6.85	144	7.00	5	1	1	I	1350	2300	6200	1600	2400	900	1900	100	G	1935	2.15	1-SH	Scin	Mag	2	Opt	Opt	62.06	55	55		25
Wright Cyclone GR-2600-A2B	176	Rad	Air	14-6⅛x6 5/16	2603.0	6.30	144	7.00	5	1	1	I	1350	2300	5800	1600	2400	900	1900	91	G	1935	2.15	1-SH	Scin	Mag	2	Opt	Opt	62.06	55	55		25
Wright Cyclone GR-2600-A5A		Rad	Air	14-6⅛x6 5/16	2603.0	6.85	144	7.14	5	1	1	I	L1350	2300	5000	1600	2400	900	1900	100	G	1950	2.17	1-SH	Scin	Mag	2	Opt	Opt	62.06	55	55		25
	(2-	Speed	Blo	wer Engine)				10.00					H1275	2300	12000																			
Wright Cyclone GR-2600-A5B		Rad	Air	14-6⅛x6 5/16	2603.0	6.30	144	7.14	5	1	1	I	L1350	2300	5000	1600	2400	900	1900	91	G	1950	2.17	1-SH	Scin	Mag	2	Opt	Opt	62.06	55	55		25
	(2-	Speed	Blo	wer Engine)				10.00					H1275	2300	11500																			
Wright 585C14BA	176	Rad	Air	14-6⅛x6 5/16	2603.0	6.90	154	7.03	5	1	1	I	1500	2400	6700	1700	2500	1000	2000	100	G	1965	1.31‡	SH	Scin	Mag	2	Opt		63.40	54¼			25
Wright 586C14BA	176	Rad	Air	14-6⅛x6 5/16	2603.0	6.85	154	7.06	5	1	1	I	L1500	2400	6700	1700	2500	1000	2000	100	G	1980	1.32‡	SH	Scin	Mag	2	Opt		63.40	54¼			25
	(2-	Speed	Blo	wer Engine)				10.02	5				H1350	2400	15000																			
Wright Cyclone 18R-3350					3350.0																										55			

ABBREVIATIONS FOR AIRCRAFT ENGINES

General

‡—Based on Maximum Horsepower
*—Optional
°—Fuel Injection system optional
▲—Applies to model with .667 Reduction Gear
‡—Auxiliary Stage Blower Ratio 6.85
†—Basic commercial models released for domestic and export sale—representative of corresponding military models in current production
††—Turbo to 25,000
(a)—Combination Battery and Magneto optional
(b)—One Magneto, one Battery
(c)—At 9500 feet.
(d)—Two speed blower, ratios 6.391 and 8.095:1
(e)—75% Power allowable
(f)—At 17,400 feet
(g)—Two speed blower, ratios 7.14 and 10.00:1
H—High Blower
(h)—Duplex
(k)—By 12⅛
L—Low Blower
(l)—Two speed blower, ratios 8.151 and 9.490:1
Liq—Liquid cooled
Mil—Military
(m)—346 for R-55; 362 for R-56
(n)—By 8⅛
(o)—Own (Claudel-Hobson license)
(p)—Two speed blower, ratios 7.134 and 10.04

Cylinder Arrangement

Hor—Horizontal Opposed
IV-L—Inverted-In-Line
IV-V—Inverted-V-Type
Pen—Pending
Rad—Radial
V-60—V-Type-60 Degrees

Cylinder Material

(1)—Nickel Iron with Aluminum Head
(2)—Aluminum with Steel Liner
(3)—Cast Iron
(4)—Cast Iron with Aluminum Head
(5)—Steel with Aluminum Head
(6)—Aluminum with cast iron liner
(7)—Steel
(8)—Nickel Iron

Valve Location

I—In head with push rods and rocker arms
OH—Overhead Camshaft

Rating

SL—Sea Level

Propeller Drive

D—Direct G—Geared

Carburetor Make

Hol—Holley
MS—Marvel-Schebler
SCH—Stromberg, Chandler-Evans or Holley
SH—Stromberg or Holley
SM—Stromberg or Marvel-Schebler
Str—Stromberg

Ignition System Make

Bos—Bosch
BS—Bendix-Scintilla Scin—Scintilla
Eis—Eisemann
Pac—Packard Make
SES—Scintilla, Edison-Splitdorf or Superior

Current Sources

B. M.—Battery and Magneto
Mag—Magneto

Starter Make

Au—Auto-Lite DR—Delco-Remy
Ecl—Eclipse Opt—Optional

Method of Starting

CEH—Compressed Air, Electric Motor or Hand Crank from Machine
EM—Electric Motor
HE—Hand Crank or Electric Motor
Opt—Optional
PE—Propeller Swing or Electric Motor
PS—Propeller Swing

Engine Manufacturers

(1)—Aircooled Motors Corp.
(2)—Rearwin Aircraft & Engine, Inc.
(3)—Aviation Mfg. Corp., Lycoming Division.
(4)—Commonwealth Aircraft, Inc.
(5)—Allied Aircraft Corp.
(6)—Built by Packard Motor Co.

Small Gasoline Power Units

MAKE AND MODEL	Designed for Use	Number of Cycles	ENGINE						Horse Power					GOVERNOR		Ignition System—Type	FUEL SYSTEM		Fuel Used	Starting Method
			Type	No. of Cylinders	Bore and Stroke (In.)	Total Displacement (Cu. In.)	Compression Ratio (to 1)	Valve Location	Rated at RPM	Continuous at RPM	Torque—Lb. Ft. at RPM	Weight (lb.)	Cooling Medium	Used	Type		Type	Make		
Briggs & Stratton (1)......N	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2x2	6.28	5.86	L	1.5–3000	1.7–3600	2.9–3600	38	A	Y	Pn	Mag	Car	Own	G	Ro
Briggs & Stratton......A	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2¼x2¼	8.95	4.26	L	1.7–2500	2.0–3200	4.0–3200	76	A	Y	Me	Mag	Car	Own	G	Ro
Briggs & Stratton......B	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2⅝x2⅝	14.21	4.47	L	2.7–2400	3.0–3200	6.0–3200	92	A	Y	Me	Mag	Car	Own	G	Ro
Briggs & Stratton......ZZ	GS,Co,Ha,Pu,Re,Af	4	Ver	1	3x3¼	22.97	4.76	L	6.0–2600	6.5–3200	12.6–3200	113	A	Y	Me	Mag	Car	Own	G	Ro
Cushman (2)......M70	Pu,Af,Ag	4	Ver	1	2⅝x2¾	14.89	5.40	L	4.0–3000	4.0–3000	7.5–2800	80	A	Y	Fb	Mag	Car	Til	G	PB
Cushman......M50	Pu,Af,Ag	4	Ver	1	2⅝x2½	13.53	5.00	L	2.0–1800	2.0–1800	6.0–1800	75	A	Y	Fb	Mag	Car	Til	G	PB
Cushman......2R14	GS,Co,Pu,Af	4	Hor	1	3¼x4½	37.33	3.67	(a)	2.0–750	2.0–750	18.5–750	195	W	Y	Fb	Mag	MV	Own	G,K,D,Ng	Hc
Cushman......3R20	GS,Co,Pu,Af	4	Hor	1	3½x4½	43.29	4.10	(a)	3.0–800	3.0–800	23.0–800	235	W	Y	Fb	Mag	MV	Own	G,K,D,Ng	Hc
Cushman......4R30	GS,Co,Pu,Af	4	Hor	1	3¾x4½	49.70	4.64	(a)	4.0–850	4.0–850	28.0–850	245	W	Y	Fb	Mag	MV	Own	G,K,D,Ng	Hc
Cushman......C34	Co,Pu,Af	4	Ver	1	4x4	50.26	4.00	(a)	(b)	(b)	26.8–1000	270	W	Y	Fb	Mag	Car	Til	G	Hc
Delco (3)......4B12	GS	4	Ver	1	2⅛x2¼	8.00	4.00	L	1.2–2100	0.9–2100	2.9–2100	97	A	N	.....	Bat	Car	.....	G	El
Delco......7B12	GS	4	Ver	1	2 5/16x2¼	9.45	5.00	L	1.6–2300	.....	3.8–2300	104	A	Y	Fb	Pat	Car	.....	G	El
Delco......2B12	GS	4	Ver	1	1 11/16x1⅝	3.64	3.40	L	.....	0.5–2250	1.1–2250	40	A	N	.....	Bat	Car	.....	G	El
Delco......10EAB3	GS	4	Ver	1	2¾x2 9/16	15.25	4.50	L	.....	1.9–1800	5.4–1800	....	A	Y	Fb	Bat	Car	.....	G	El
Homelite (4)......B	GS,Co,Pu,Bl	2	Inv	1	2x1½	4.70	6.00	R	1.7–3400	1.7–3400	.....	....	A	Y	Ce	Mag	Car	Til	G	Bp
Homelite......HRU	GS,Co,Pu,Bl	2	Ver	1	2⅜x2⅛	9.40	6.00	R	4.0–3500	4.0–3500	.....	....	A	Y	Ce	Mag	MV	Own	G	Bp
Indian (8)......84-A	GS,Co,Pu,Re	4	Vee	2	2⅞x3½	45.44	6.00	L	23.0–4000	.....	27.5–3200	147	A	Y	Ce	Mag	Car	Lin	G	Hd
IHC (5)......LB, 3-5 Hp	Pu, Re, Af	4	Hor	1	4x4⅛	51.80	4.60	I	(d)	(d)	33.5–750	374	W	Y	Fb	Mag	MV	Own	G,K,D,Ng	Hc
IHC......LB, 1½-2½ Hp	Ha,Pu,Af	4	Hor	1	3⅛x3¼	24.90	4.70	I	(e)	(e)	16.5–875	194	W	Y	Fb	Mag	MV	Own	G,K,D,Ng	Hc
Jacobsen (6)......J100	GS,Co,Pu,Re,Af,Ha	2	Hor	1	2x1½	4.70	5.50	N	1.0–3000	.....	.....	....	A	Y	Av	Mag	Car	Til	G	Rr
Jacobsen......J150	GS,Co,Pu,Re,Af,Ha	2	Hor	1	2¼x1¾	6.95	5.50	N	1.5–3000	.....	.....	....	A	Y	Av	Mag	Car	Til	G	Rr
Jacobsen......J300	GS,Co,Pu,Re,Af,Ha	2	Hor	1	2¾x2½	14.85	5.50	N	3.0–2600	.....	.....	....	A	Y	Av	Mag	Car	Til	G	Rr
Johnson Iron Horse (7).X500	GS,Ha,Pu,Ah	4	(c)	1	2¼x1¾	6.96	4.50	L	1.3–2400	1.2–2400	2.9–2400	42	A	Y	Fb	Mag	Car	Til	G	Pe
Lauson (9)......RLC	GS,Co,Ha,Pu,Re,Af	4	Ver	1	1¾x1⅞	4.51	5.50	L	0.8–2400	0.6–2400	1.7–2400	25	A	Y	Fb	Mag	Car	Til	G	Ro
Lauson......TLC	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2¼x2¼	8.95	6.00	L	1.9–2400	1.6–2400	4.2–2400	52	A	Y	Fb	Mag	Car	Til	G	Ro
Lauson......RSC	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2x1⅞	5.89	6.00	L	1.2–2400	.9–2400	2.5–2400	27	A	Y	Fb	Mag	Car	Til	G	Ro
Lauson......PAC	GS,Co,Ha,Pu,Re,Af	4	Ver	1	2⅞x2¾	17.85	6.00	L	4.0–2400	3.3–2400	8.8–2400	92	A	Y	Fb	Mag	Car	MS	G	Ro
Le Roi (10)......V	GS,Pu,Re,Af	4	Ver	2	2⅞x3½	90.80	.....	L	7.8–2000	6.0–1800	22.8–1200	325	W	Y	Fb	Mag	Car	.....	G	HE
Mall (11)......17410A	CS	2	Ver	1	2⅜x2¾	12.20	4.90	....	5.0–4000	.....	.....	52	A	N	.....	Mag	Car	Brk	G	Bp
Mall......258	CS	2	Hp	2	2 1/16x1½	10.00	4.80	....	4.0–4000	.....	.....	37	A	N	.....	Mag	Car	Brk	G	Bp
Novo (13)......CA-33	GS,Co,Pu,Re,Hs	4	Ver	1	3¼x4	33.00	4.25	L	4.4–1400	3.5–1400	21.4–1400	245	A	Y	Fb	Mag	Car	Hol	G	Hc
Novo......CW-33	GS,Co,Pu,Re,Hs	4	Ver	1	3¼x4	33.00	5.50	L	4.2–1200	3.4–1200	18.5–1200	340	W	Y	Fb	Mag	Car	Hol	G	Hc
Novo......CW-47	GS,Co,Pu,Re,Hs	4	Ver	2	2¾x4	47.00	5.50	L	6.0–1200	4.8–1200	25.7–1200	395	W	Y	Fb	Mag	Car	Hol	G	Hc
Novo......CW-66	GS,Co,Pu,Re,Hs	4	Ver	2	3¼x4	66.00	5.50	L	8.5–1200	6.8–1200	37.5–1200	395	W	Y	Fb	Mag	Car	Hol	G	Hc
Onan (14)......1B	GS	4	Ver	1	2¾x2¾	16.30	4.80	L	2.5–1800	2.5–1800	7.3–1800	†177	A	Y	‡	Mag	Car	Zen	G	Ro
Onan......OTC	GS	4	Op	2	2⅝x2¼	24.35	5.90	L	4.1–2850	3.4–1800	9.9–1800	†155	A	Y	‡	Mag	Car	Zen	G	Ro
Onan......W3M or S	GS	4	IL	2	3x2¾	38.80	5.50	L	7.2–1850	7.1–1800	20.4–1850	†450	W	Y	‡	BM	Car	Zen	G	Hc
Onan......V45	GS	4	Vee	4	3x2¾	77.80	5.50	L	14.5–1800	14.5–1800	42.3–1800	†640	W	Y	.....	BM	Car	Zen	G	Hc
Onan......OFA	GS	4	Op	4	2¾x2¼	53.45	6.00	L	9.0–2850	7.5–1800	21.9–1800	365	A	Y	‡	Bat	Car	MS	G	HE
Onan......IC	GS	4	Ver	1	2¼x2¼	8.95	5.00	L	1.4–2100	1.0–1800	2.9–1800	105	A	Y	‡	Mag	Car	Zen	G	HE
Universal (15)......AFTC	GS	4	Ver	2	3x3½	49.50	5.79	L	5.0–1200	.....	25.0–1200	385	W	Y	Me	BM	Car	Str	G	HE
Wisconsin (16)......AA	GS,Co,Pu,Re,Af,In	4	Ver	1	2¼x2¾	10.90	4.40	L	2.0–2600	1.6–2600	4.7–1900	76	A	Y	.....	Mag	Car	Str	G	B
Wisconsin......AB	GS,Co,Pu,Re,Af,In	4	Ver	1	2½x2¾	13.50	4.40	L	3.0–2600	2.4–2600	6.7–1700	76	A	Y	.....	Mag	Car	Str	G	B
Wisconsin......ABS	GS,Co,Pu,Re,Af,In	4	Ver	1	2½x2¾	13.50	5.17	....	4.0–3200	3.2–3200	6.9–2500	79	A	Y	.....	Mag	Car	Str	G	B
Wisconsin......AK	GS,Co,Pu,Re,Af,In	4	Ver	1	2⅞x2¾	17.80	4.60	L	4.1–2400	3.3–2400	9.5–1700	77	A	Y	.....	Mag	Car	Str	G	B
Wisconsin......AKS	GS,Co,Pu,Re,Af,In	4	Ver	1	2⅞x2¾	17.80	5.12	....	5.0–3200	4.0–3200	10.0–2000	....	A	Y	.....	Mag	Car	Str	G	B
Wisconsin......ADH	GS,Co,Pu,Re,Af,In	4	Ver	1	2¾x3¼	19.30	5.10	L	5.1–2600	4.1–2600	10.8–2000	125	A	Y	.....	Mag	Car	Str	G	HB
Wisconsin......AEH	GS,Co,Pu,Re,Af,In	4	Ver	1	3x3¼	23.00	5.10	L	6.1–2600	4.9–2600	12.9–2000	130	A	Y	.....	Mag	Car	Str	G	HB
Wisconsin......AGH	GS,Co,Pu,Re,Af,In	4	Ver	1	3½x4	38.50	4.60	L	8.4–2100	6.7–2200	24.2–1300	....	A	Y	.....	Mag	Car	Str	G	HB
Wisconsin......AHH	GS,Co,Pu,Re,Af,In	4	Ver	1	3⅝x4	41.30	4.55	L	9.2–2200	7.4–2200	25.9–1400	180	A	Y	.....	Mag	Car	Str	G	HB

ABBREVIATIONS

†—Weight includes generator
‡—Flyweights in cam gear

A—Air
(a)—"F" Head; In-head for Intake, L-head for exhaust
Af—Auxiliary Farm Implement equipment
Ag—Auto glides
Ah—Aircraft heater
Av—Air Vane

B—Belt
(b)—4 to 6 Hp at 850 to 1300 rpm
Bat—Battery
Bl—Blowers
BM—Battery or Magneto
Bp—Belt or Pulley
Brk—Bracke

(c)—30° from horizonta
Car—Carburetor
Ce—Centrifugal
Co—Air Compressors
CS—Chain Saws

D—Distillate
(d)—3 to 5 Hp at 600 to 1000 rpm

(e)—1½ to 2½ Hp at 600 to 1000 rpm
El—Electric

Fb—Flyball throttling

G—Gasoline
GS—Generator Sets

Ha—Home appliances
HB—Hand crank or Belt
Hc—Hand crank
Hd—Hand
HE—Hand crank or electric
Hol—Holley Carburetor Co.
Hor—Horizontal
Hp—Horizontal Apposed
Hs—Hoists

I—In-head
IL—In Line
In—Industrial
Inv—Inverted

K—Kerosene

L—Valves at side (L-Head)
Lin—Linkert

Mag—Magneto
Me—Mechanical
MS—Marvel-Schebler Carburetor Div.
MV—Mixing Valve

N—No or None
Ng—Natural gas

Op—Opposed

PB—Pedal or Belt or Pulley
Pe—Pedal
Pu—Pumps
Pn—Pneumatic

R—Rotary valves
Re—Refrigerating equipment
Ro—Rope
Rr—Recoil or Rope

Str—Stromberg Carburetor Div.

Til—Tillotsen Mfg. Co.

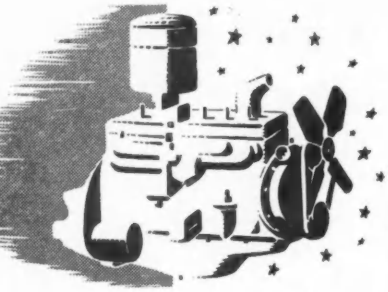
Ver—Vertical

W—Water

Y—Yes

Zen—Zenith Carburetor Div.

(1)—Briggs & Stratton Corp.
(2)—Cushman Motor Works
(3)—Delco Appliance Division
(4)—Homelite Corporation
(5)—International Harvester Co.
(6)—Jacobsen Mfg. Co.
(7)—Johnson Motors
(8)—Indian Motorcycle Company
(9)—The Lauson Company
(10)—Le Roi Company
(11)—Mall Tool Company
(13)—Novo Engine Company
(14)—D. W. Onan & Sons
(15)—Universal Motors Company
(16)—Wisconsin Motor Corp.



AMERICAN

Line Number	Engine Make and Model	Designed for	Number of Cylinders, Bore and Stroke (In.)	Maximum Brake Hp. at Specified R.P.M. — With Bare Engine	Maximum Brake Hp. at Specified R.P.M. — With Standard Accessories	Piston Displacement (Cu. In.)	Compression Ratio	Maximum Torque at R.P.M. (Lb. Ft.) with or without Accessories	Cylinder Liners—Type	Crankcase—Upper Half Integral with Cylinders	Valves — Arrangement	Valves — Exhaust Head Material (S.A.E. No.)	Max. Head Diameter (In.) — Intake	Max. Head Diameter (In.) — Exhaust	Min. Port Diameter (In.) — Intake	Min. Port Diameter (In.) — Exhaust	Lift (In.) — Intake	Lift (In.) — Exhaust	Stem Diameter (In.) — Intake	Stem Diameter (In.) — Exhaust
1	Allis-Chalmers........B-15	Tr,Ind	4-3⅜x3½	24-1800	22-1800	125.0	5.75	74-1100 (EA)	W	In	I	Sil	1.43	1.31	1.20	1.03	.378	.378	.344	.344
2	Allis-Chalmers........W-25	Tr,Ind	4-4x4	44-1800	40-1800	201.1	5.00	128-1200 (EA)	W	In	I	Sil	1.68	1.50	1.50	1.32	.376	.376	.372	.372
3	Allis-Chalmers........U-40	Tr,Ind	4-4½x5	56-1400	51-1400	318.0	4.75	200-900 (EA)	W	In	I	Sil	2.03	1.78	1.75	1.50	.375	.375	.372	.372
4	Allis-Chalmers........E-60	Tr,Ind	4-5¼x6½	86-1200	78-1200	563.0	5.20	400-650 (EA)	W	In	I	Sil	2.21	2.21	2.00	2.00	.440	.417	.500	.500
5	Allis-Chalmers........L-90	Tr,Ind	6-5¼x6½	128-1200	117-1200	844.0	5.20	590-650 (EA)	W	In	I	Sil	2.21	2.21	2.00	2.00	.440	.417	.500	.500
6	Autocar........377	T	6-4x5	119-2800	112-2800	377.0	5.75	280-1400 (BE)	N	Se	L	3140	1.90	1.78	1.68	1.56	.375	.375	.437	.437
7	Autocar........447	T	6-4¼x5¼	133-2500	122-2500	447.0	5.75	351-1100 (BE)	N	Se	L	CNS	2.06	1.93	1.87	1.75	.375	.375	.437	.437
8	Autocar........501	T	6-4½x5¼	145-2500	134-2500	501.0	5.75	395-950 (BE)	N	Se	L	CNS	2.06	1.93	1.87	1.75	.375	.375	.437	.437
9	Brennan........Imp. De Luxe	M	4-2x3	20-3900	15-3900	45.0	7.00	31-2500 (EA)	N	Se	I	Sil	1.00	1.00	.875	.875	.250	.250	.312	.312
10	Brennan........20	Ind	4-2¼x3⅛	20-3900	15-3900	50.0	7.40	34-3200 (EA)	N	Se	L	Sil	1.12	1.00	.875	.875	.250	.250	.312	.312
11	Brennan....Imp. De Luxe Spec.	M	4-2¼x3⅛	25-4000	20-4000	50.0	7.40	34-3200 (EA)	N	Se	I	Sil	1.12	1.00	.875	.875	.250	.250	.312	.312
12	Brennan........M-4	M	4-4x5	45-1800	38-1800	251.0	5.00	155-1000 (EA)	N	Se	L	NCI	....	....	....	....	....	....	....	....
13	Brennan........CE	Ind	4-4½x5	54-1600	45-1600	318.0	5.00	203-1000 (EA)	N	Se	L	Sil	2.00	2.00	1.87	1.87	.375	.375	.375	.375
14	Brennan........E-4	M	4-4½x5	54-1600	45-1600	318.0	5.00	203-1000 (EA)	N	Se	L	Sil	2.00	2.00	1.87	1.87	.375	.375	.375	.375
15	Brennan........B-70	T,B,Tr,Ind	6-4x5½	90-2000	75-2000	415.0	4.50	278-900 (EA)	N	Se	I	Sil	2.12	2.12	2.00	2.00	.375	.375	.437	.437
16	Brennan........100	M	6-4x5½	94-2000	80-2000	415.0	6.00	278-900 (EA)	N	Se	I	Sil	2.12	2.12	2.00	2.00	.375	.375	.437	.437
17	Brennan........B-100	T,B,Tr,Ind	6-4⅜x5½	94-2000	80-2000	496.0	4.50	350-1200 (EA)	N	Se	I	Sil	2.12	2.12	2.00	2.00	.375	.375	.437	.437
18	Brennan........125	M	6-4⅜x5½	110-2200	94-2200	496.0	6.00	350-1200 (EA)	N	Se	I	Sil	2.12	2.12	2.00	2.00	.375	.375	.437	.437
19	Brennan........150	M	6-4½x6½	150-2000	130-2000	620.3	6.00	500-1200 (EA)	N	Se	I	Sil	2.50	2.50	2.12	2.12	.437	.437	.500	.500
20	Bridgeport........F-5	M	1-3¾x4½	....	6-1200	49.0	....	....	N	In	I	Sil	1.50	1.50	....	....	....	....	.312	.312
21	Bridgeport........71	M	1-5½x6½	....	10-600	154.0	....	....	N	Se	L	NCI	2.25	2.25	2.00	2.00	....	....	.500	.500
22	Bridgeport........F-10	M	2-3¾x4½	....	12-1200	99.0	....	....	N	In	I	Sil	1.50	1.50	....	....	....	....	.312	.312
23	Bridgeport........162	M	2-5½x6½	....	20-650	308.0	....	....	N	Se	L	NCI	2.25	2.25	2.00	2.00	....	....	.500	.500
24	Bridgeport........182	M	2-6½x7½	....	25-500	497.0	....	....	N	Se	L	NCI	2.37	2.37	2.00	2.00	....	....	.500	.500
25	Bridgeport........243	M	3-6½x7½	....	40-500	746.0	....	....	N	Se	L	NCI	2.37	2.37	2.00	2.00	....	....	.500	.500
26	Bridgeport........F-20	M	4-2¾x4	....	27-2500	95.0	....	....	N	In	L	Sil	1.12	1.12	....	....	....	....	.312	.312
27	Bridgeport........Pilot	M	4-4¼x5	....	55-2000	283.0	....	225-2000 (EA)	N	In	L	Sil	1.87	1.87	1.62	1.62	....	....	.375	.375
28	Bridgeport........304	M	4-5½x6½	....	45-700	617.0	....	....	N	Se	L	NCI	2.25	2.25	2.00	2.00	....	....	.500	.500
29	Bridgeport........404	M	4-6½x7½	....	65-600	995.0	....	....	N	Se	L	NCI	2.37	2.37	2.00	2.00	....	....	.500	.500
30	Bridgeport........Piloteer	M	6-4x4¾	....	80-2200	358.0	....	300-2200 (EA)	N	In	L	Sil	2.00	2.00	1.75	1.75	....	....	.375	.375
31	Buda........HP-217	T,Tr	4-3 13/16x4¾	55-2400	47-2400	217.0	5.50	123-1200 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
32	Buda........4HM-217-MD	M	4-3 13/16x4¾	....	56-2400	217.0	5.70	148-1400 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
33	Buda........4HM-217-MHD	M	4-3 13/16x4¾	....	48-1800	217.0	5.70	146-1400 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
34	Buda........4HM-217-HD	M	4-3 13/16x4¾	....	30-1200	217.0	5.70	131-1200 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
35	Buda........HP-234	T,Tr	4-3 13/16x5⅛	59-2400	50-2400	234.0	5.83	133-1200 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
36	Buda........YR-425	T	4-4¾x6	57-1400	48-1400	425.3	3.80	226-800 (EA)	N	Se	L	2112	2.37	2.37	2.12	2.12	.281	.312	.434	.434
37	Buda........FRH	T,B,Tr	4-5½x6½	78-1200	66-1200	618.0	4.60	350-600 (EA)	N	Se	L	2112	2.50	2.50	2.25	2.25	.375	.375	.434	.434
38	Buda........JL-877	Tr,Ind	4-6¼x7⅛	122-1200	104-1200	874.0	4.80	535-700 (EA)	N	Se	L	2112	2.93	2.93	2.50	2.50	.375	.375	.497	.497
39	Buda........HP-260	T,B	6-3½x4½	68-2800	58-2800	260.0	4.75	139-1100 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
40	Buda........HP-298	T,B,Tr	6-3¾x4½	77-2800	65-2800	298.0	4.75	161-1100 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
41	Buda........HP-326	T,B,Tr	6-3 13/16x4¾	78-2400	66-2400	326.0	5.40	188-1000 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
42	Buda........HP-351	T,Tr	6-3 13/16x5⅛	84-2400	71-2400	351.0	5.83	201-1000 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
43	Buda........6HM-326-MD	M	6-3 13/16x4¾	80-2400	80-2400	326.0	5.70	225-900 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
44	Buda........6HM-326-MHD	M	6-3 13/16x4¾	....	70-1800	326.0	5.70	225-900 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
45	Buda........6HM-326-HD	M	6-3 13/16x4¾	....	46-1200	326.0	5.70	200-900 (EA)	N	In	L	2112	1.65	1.53	1.50	1.37	.344	.344	.372	.372
46	Buda........K-393	T,B,Tr	6-4 3/16x4¾	101-2400	86-2400	393.0	4.80	216-1100 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
47	Buda........K-428	T,B,Tr	6-4⅜x4¾	107-2400	91-2400	428.0	5.33	240-1100 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
48	Buda........6KM-428-MD	M	6-4⅜x4¾	....	110-2400	428.0	5.50	299-1200 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
49	Buda........6KM-428-MHD	M	6-4⅜x4¾	....	96-1800	428.0	5.50	299-1200 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
50	Buda........6KM-428-HD	M	6-4⅜x4¾	....	60-1200	428.0	5.50	278-900 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
51	Buda........L-525	T,B,Tr	6-4½x5½	110-2400	94-2400	525.0	4.75	287-800 (EA)	N	In	L	2112	1.90	1.78	1.75	1.62	.400	.400	.372	.372
52	Buda........LO-525	T,B,Tr	6-4½x5½	135-2400	115-2400	525.0	5.00	330-1100 (EA)	N	In	I	2112	1.96	1.68	1.75	1.50	.468	.468	.372	.372
53	Buda........JL-1335	Tr,Ind	6-6¼x7¼	164-1000	140-1000	1334.6	4.40	780-600 (EA)	N	Se	L	2112	2.93	2.93	2.50	2.50	.438	.438	.497	.497
54	Buda........P-1879	Ind	6-6¾x8¾	232-1000	197-1000	1879.0	4.50	1110-750 (EA)	W	In	I	2112	2.71	2.53	2.50	2.28	.703	.703	.558	.558
55	Buda........PHG-1879	Ind	6-6¾x8¾	232-1000	197-1000	1879.0	....	1200-750 (EA)	W	In	I	2112	2.71	2.53	2.50	2.28	.703	.703	.558	.558
56	Buda........MO-970	T,B,Tr,R,M	6-5⅝x6½	172-1400	147-1400	970.0	5.43	545-1000	W	In	I	2112	2.64	2.02	2.37	1.87	.540	.540	.433	.433
57	Buda........MO-893	T,B,Tr,R,M	6-5⅝x6	199-2000	170-2000	893.0	5.50	490-1000	W	In	I	2112	2.64	2.02	2.37	1.87	.540	.540	.433	.433
58	Buffalo........BA	M,Ind	4-3½x5	45-1800	40-1800	192.0	5.00	131-1400 (EA)	N	In	L	NCI	1.93	1.93	1.75	1.75	.312	.375	.375	.375
59	Buffalo........RA-4	M,Ind	4-5⅞x7	120-1200	110-1200	759.0	4.60	525-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.540	.540	.500	.500
60	Buffalo........RAB-4	M,Ind	4-6½x7	145-1200	130-1200	929.0	5.00	635-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.625	.540	.500	.500
61	Buffalo........ATT-4	M,Ind	4-8¼x9	275-1200	250-1200	1925.0	4.50	1176-900 (EA)	N	Se	L	Sil	4.12	4.06	3.62	3.44	.812	.812	.683	.683
62	Buffalo........RA-6	M,Ind	6-5⅞x7	180-1200	160-1200	1138.0	4.60	790-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.540	.540	.500	.500
63	Buffalo........RAB-6	M,Ind	6-6½x7	215-1200	195-1200	1393.0	5.00	955-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.625	.540	.500	.500
64	Buffalo........ATT-6	M,Ind	6-8¼x9	425-1200	375-1200	2887.0	4.50	1764-900 (EA)	N	Se	L	Sil	4.12	4.06	3.62	3.44	.812	.812	.683	.683
65	Buffalo........RA-8	M,Ind	8-5⅞x7	240-1200	220-1200	1518.0	4.60	1050-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.540	.540	.500	.500
66	Buffalo........RAB-8	M,Ind	8-6½x7	300-1200	270-1200	1858.0	5.00	1275-1200 (EA)	N	Se	I	Sil	3.09	2.84	2.87	2.62	.625	.540	.500	.500
67	Buffalo........ATT-8	M,Ind	8-8¼x9	550-1200	500-1200	3840.0	4.50	2352-900 (EA)	N	Se	L	Sil	4.12	4.06	3.62	3.44	.812	.812	.683	.683
68	Chevrolet........1942	C,T,B	6-3½x3¾	90-3300	83-3200	216.5	6.50	168-1100 (EA)	N	In	I	AS	1.64	1.46	1.25	1.20	.294	.312	.341	.340
69	Chevrolet........1942	T,B	6-3 9/16x3 15/16	93-3100	83.5-3000	235.5	6.62	182-1000 (EA)	N	In	I	AS	1.64	1.46	1.25	1.20	.294	.312	.341	.340
70	Chris-Craft........B	M	4-3¼x4	....	60-3200	132.7	7.50	108-2400 (EA)	N	In	L	CNS	1.50	1.37	1.25	1.12	.312	.312	.310	.310
71	Chris-Craft........K	M	6-3 7/16x4⅛	....	95-3200	229.7	7.35	173-1800 (EA)	N	In	L	CNS	1.60	1.39	1.46	1.25	.312	.312	.310	.310
72	Chris-Craft........M	M	6-4x4¼	....	130-3000	320.4	7.50	239-2400 (EA)	N	In	L	Sil	1.87	1.78	1.71	1.56	.356	.356	.372	.372
73	Chris-Craft........W	M	6-4¼x4¾	....	160-3000	404.3	6.40	322-1500 (EA)	N	In	L	AUS	2.06	1.87	1.81	1.62	.388	.388	.372	.372
74	Chrysler........Ace-M6	M	6-3¼x4⅜	....	† 92-3200	217.7	6.60	180-1200 (EA)	N	In	L	Sil	1.53	1.41	1.31	1.28	.371	.369	.340	.340
75	Chrysler........Crown-M7	M	6-3 7/16x4½	....	†115-3200	250.6	6.60	205-1200 (EA)	N	In	L	Sil	1.72	1.53	1.44	1.37	.371	.369	.340	.340
76	Chrysler........Royal-M8	M	8-3¼x4⅞	....	†141-3200	323.5	6.80	270-2000 (EA)	N	In	L	Sil	1.53	1.35	1.34	1.22	.371	.369	.340	.340
77	Chrysler........Twin Royal-M11	M	(m)-3¼x4⅞	....	256-2600	647.0	6.80	540-2000	N	In	L	Sil	1.53	1.35	1.34	1.22	.371	.369	.340	.340

(For abbreviations see pages 138-139)

GASOLINE ENGINES

Valves: Angle (Deg.)	Valves: Seats: Inserts Used?	Valves: Seats: Insert Material (S.A.E. No.)	Camshaft Drive—Type	Pistons: Material	Pistons: Weight with Pins, Rings, Bushings (Oz.)	Pistons: Piston Pin—Diameter and Length (In.)	Number of Rings per Piston	Connecting Rods: Material	Connecting Rods: Center to Center Length (In.)	Connecting Rods: Weight with Bushing and Cap (Oz.)	Crankshaft: Material	Crankshaft: Counter Balance Used	Crankshaft: Crank-Pin Diameter and Length (In.)	Crankshaft: Main Bearings: Number	Crankshaft: Main Bearings: Diameter and Length (In.): Front	Crankshaft: Main Bearings: Diameter and Length (In.): Rear	Oil Pressure to—	Spark Plug—Thread Size	Carburetor: Make	Carburetor: Size	Engine Weight without Carburetor or Ignition (Lb.)	Overall Dimensions (In.): Width	Overall Dimensions (In.): Height	Overall Dimensions (In.): Length	Line Number
45	N	......	HG	CI	42	.813x2.87	4	1040	6½	29	1045	N	1.93x1.43	3	2.25x1.75	2.25x1.50	aceg	14 mm	Zen	⅞	360	16 5/16	31⅝	27	1
45	E	TA	HG	CI	67	.989x3.50	4	1040	7½	42	1045	N	2.37x1.75	3	2.43x1.93	2.50x1.75	abcdeg	14 mm	Zen	1	520	23	31⅜	33½	2
30	E	TA	HG	CI	99	1.31x4.06	5	1045	9½	92	1045	N	2.37x2.37	3	2.50x2.31	2.50x2.75	abcdeg	⅞-18	Zen	1¼	985	26	37½	43¾	3
45	E	TA	HG	CI	162	1.50x4.87	4	1040	13	182	1045	N	2.75x3.24	3	3.00x3.50	3.00x4.75	abcdeg	⅞-18	Zen	1½	2020	27	44⅞	53	4
45	E	TA	HG	CI	162	1.50x4.87	4	1040	13	182	1945	N	2.75x3.24	4	3.00x3.50	3.00x4.75	abcdeg	⅞-18	Zen(2)	1½	2810	29¾	63 1/16	72½	5
45	E	71360	HG	Al	43	1.12x3.28	4	2340	10⅛	65	1050	N	2.37x1.44	7	3.25x1.87	3.25x2.60	abcde	18 mm	Zen	1¼	1165	27½	41	45	6
45	E	71360	HG	Al	51	1.12x3.68	4	2340	10¼	78	1050	N	2.50x1.58	7	3.25x1.87	3.25x2.87	abcde	18 mm	Str	1¾	1320	27½	41½	47	7
45	E	71360	HG	Al	57	1.12x3.93	4	2340	10¼	78	1050	N	2.50x1.58	7	3.25x1.87	3.25x2.87	abcde	18 mm	Str	1¾	1330	27½	41½	47	8
45	N	......	HG	Al	6	.625x1.87	3	1045	5¾	14	1045	N	1.31x1.25	2	2.50x1.50	2.50x1.50	abcde	14 mm	Tli	¾	160	12¾	17⅝	29	9
45	N	......	HG	Al	6	.625x2.00	3	1045	5¾	14	1045	Y	1.31x1.25	3	2.50x1.50	2.50x1.50	abcde	14 mm	Zen	¾	128	12¾	17⅝	18¾	10
45	N	......	HG	Al	6	.625x2.00	3	1045	5¾	14	1045	N	1.31x1.25	3	2.50x1.50	2.50x1.50	abcde	....	Zen	11/16	165	12¾	17⅝	29	11
......	......	......	HG	CI	......	1.17x4.00	4	AS	11	......	CNS	N	2.56x2.00	3	2.12x4.25	2.12x2.25	abcd	....	Str	1¼	650	12 7/16	19½	53¼	12
45	N	......	HG	SS	80	1.17x4.00	4	1045	11	64	1045	N	2.50x2.50	3	2.50x4.25	2.50x3.50	abcde	....	Str	1¼	600	21	29¾	37⅛	13
45	N	......	HG	SS	72	1.17x4.00	5	1045	11	64	1045	N	2.50x2.50	3	2.50x4.25	2.50x3.50	abcder	....	Str	1¼	950	16	18	53	14
45	N	......	HG	SS	64	1.17x3.87	4	CNS	11	65	CNS	N	2.50x2.00	3	2.75x4.50	2.75x3.00	abce	....	Str	1½	800	25¾	33¾	49	15
45	N	......	HG	SS	64	1.17x3.87	4	AS	......	......	CNS	N	2.50x2.00	3	2.75x4.50	2.75x3.00	abcdeg	....	Str	1½	800	19¾	24¾	65	16
45	N	......	HG	SS	76	1.25x3.87	5	CNS	11	65	CNS	N	2.50x2.00	3	2.75x4.50	2.75x3.00	abce	....	Str	1½	875	25¾	33¾	49	17
45	N	......	HG	SS	70	1.25x3.87	5	AS	11	65	CNS	N	2.50x2.00	3	2.75x4.50	2.75x4.50	abcdeg	....	Str	1½	900	19¾	24¾	65	18
45	N	......	BG	SS	72	1.37x4.00	5	AS	12	80	CNS	Y	2.62x2.67	7	2.62x5.00	2.62x3.50	abcd	....	Str	1¾	1450	20	30	74	19
45	N	......	SG	CI	......	.750x3.37	3	DFS	......	......	......	Y	1.37x1.50	2	1.37x2.50	1.37x2.50	Splash	⅞-18	....	1	204	13	24	30	20
45	N	......	SG	CI	124	1.25x5.25	5	DFS	12½	136	......	N	2.00x3.00	2	2.00x5.50	2.00x5.50	Splash	⅞-18	....	1¼	510	20	34	47	21
45	N	......	HG	CI	......	.750x3.37	...	DFS	......	......	......	Y	1.37x1.50	2	1.37x2.50	1.37x2.50	Splash	⅞-18	....	1¼	308	13	25	33	22
45	N	......	HG	CI	124	1.25x5.25	5	DFS	12½	136	......	N	2.00x3.00	3	2.00x5.50	2.00x5.50	ML	⅞-18	....	1¼	1010	20	35	56	23
45	N	......	SG	CI	272	1.50x6.00	5	DFS	15½	208	......	N	2.37x3.00	5	2.37x6.00	2.37x6.00	ML	⅞-18	....	1½	......	21	40	63	24
45	N	......	HG	CI	272	1.50x6.00	5	DFS	15½	208	......	N	2.37x3.00	4	2.37x6.00	2.37x6.00	ML	⅞-18	....	1½	2000	21	40	77	25
45	N	......	HG	CI	......	.625x2.37	3	DFS	......	......	DFS	N	1.50x1.75	3	1.50x2.75	1.50x2.75	ab	⅞-18	....	1¼	382	17	22	35	26
45	Bo	AS	HG	CI	64	1.37x3.50	4	DFS	9½	56	......	N	2.00x2.25	3	2.00x3.00	2.00x3.25	abcde	⅞-18	....	1¼	920	17	28½	53	27
45	N	......	HG	CI	124	1.25x5.25	5	DFS	12½	136	......	N	2.00x3.00	5	2.00x5.50	2.00x5.50	ML	⅞-18	....	1½	1700	20	35	76	28
45	N	......	HG	CI	272	1.50x6.00	5	DFS	15½	208	......	N	2.37x3.00	5	2.37x6.00	2.37x6.00	ML	⅞-18	....	1½	2400	21	40	87	29
45	Bo	AS	HG	CI	64	1.25x3.50	4	DFS	9⅝	56	......	N	2.50x1.75	7	3.00x2.00	3.00x3.00	abcde	⅞-18	....	1½	1500	18	30	64	30
45	N	......	HG	CI	42	1.12x3.22	4	CS	9½	42	CS	N	2.12x1.62	5	3.00x1.50	3.00x2.12	abcde	18 mm	Zen	1¼	590	25¾	31 1/16	38 9/16	31
45	N	......	HG	CI	42	1.12x3.22	4	CS	9½	42	CS	N	2.12x1.62	5	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1¼	770	23¼	31 1/16	43⅜	32
45	N	......	HG	CI	42	1.12x3.22	4	CS	9½	42	CS	N	2.12x1.62	5	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1¼	770	23¼	31 1/16	43⅜	33
45	N	......	HG	CI	42	1.12x3.22	4	CS	9½	42	CS	N	2.12x1.62	5	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1¼	770	23¼	31 1/16	43⅜	34
45	N	......	HG	CI	42	1.12x3.22	4	CS	9½	42	CS	N	2.12x1.62	5	3.00x1.50	3.00x2.12	abcde	18 mm	Str	1¼	770	23¼	31 1/16	43⅜	35
45	E	JM	HG	CI	111	1.43x4.11	4	AS	13¼	106	CS	N	2.50x2.87	3	2.50x3.00	2.50x4.50	abcde	⅞-18	Zen	1½	1087	25¾	36 11/16	47½	36
45	E	DC	HG	CI	144	1.37x4.87	4	AS	14⅜	163	CS	N	2.50x3.12	3	2.25x4.12	2.62x4.69	abcde	⅞-18	Zen	1½	1430	28¾	40 7/16	52 9/16	37
30	E	DC	HG	CI	199	2.00x5.33	4	AS	14⅝	227	CS	N	3.00x3.31	3	3.00x4.75	3.00x4.75	abcde	⅞-18	Zen	1¾	1925	30	40 11/32	58½	38
45	N	......	HG	CI	37	1.12x2.97	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcde	18 mm	Zen	1½	825	25¾	33 1/16	39 21/32	39
45	N	......	HG	CI	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcde	18 mm	Zen	1½	825	25¾	33 1/16	39 21/32	40
45	N	......	HG	CI	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcde	18 mm	Zen	1½	885	25¾	33 1/16	39 21/32	41
45	N	......	HG	CI	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcde	18 mm	Zen	1½	905	25¾	33 1/16	39 21/32	42
45	N	......	HG	CI	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1½	1010	22⅝	28 11/16	54½	43
45	N	......	HG	Al	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1½	1010	22⅝	28 11/16	54½	44
45	N	......	HG	Al	42	1.12x3.25	4	CS	9½	42	CS	N	2.12x1.62	7	3.00x1.50	3.00x2.12	abcder	18 mm	Str	1½	1010	22⅝	28 11/16	54½	45
45	N	......	HG	CI	66	1.25x3.47	4	CS	9½	58	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcde	18 mm	Zen	1¾	905	25¾	30 11/32	47 9/32	46
45	N	......	HG	Al	68	1.25x3.82	4	CS	9½	58	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcde	18 mm	Zen	1¾	905	25¾	30 11/32	47 7/32	47
45	N	......	HG	CI	68	1.25x3.82	4	CS	9½	58	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcder	18 mm	Str	1¾	1320	24 11/16	29½	60 11/16	48
45	N	......	HG	CI	68	1.25x3.82	4	CS	9½	58	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcder	18 mm	Str	1¾	1320	24 11/16	29½	60 11/16	49
45	N	......	HG	CI	68	1.25x3.82	4	CS	9½	58	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcder	18 mm	Str	1¾	1320	24 11/16	29½	60 11/16	50
45	E	DC	HG	CI	88	1.25x3.81	4	CS	11	66	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcde	18 mm	Zen	1¾	950	25¾	33 7/32	47 9/32	51
30	E	JM	HG	Al	88	1.25x3.81	5	AS	11	78	CS	N	2.37x1.75	7	3.00x1.75	3.00x2.50	abcdeg	14 mm	Zen	1¾	1195	27 9/16	38 11/32	49⅜	52
30	E	DC	HG	CI	199	2.00x5.33	4	AS	15¼	239	CS	Y	3.50x3.31	4	3.50x4.75	3.50x4.75	abcde	⅞-18	Zen	2	3700	28⅝	43	74 7/16	53
45	E	DC	HG	Ala	263	2.75x5.53	5	CS	17¾	430	CS	Y	3.75x3.50	7	3.75x2.31	3.75x3.48	abcdeg	18 mm	Zen(2)	2	9000	48	68 5/16	86 9/32	54
45	E	DC	HG	Ala	263	2.75x5.53	5	CS	17¾	430	CS	Y	3.75x3.50	7	3.75x2.31	3.75x3.48	abcdeg	18 mm	Zen(2)	2	9000	48	68 5/16	83 5/32	55
30	E	Jad	HG	CI	152	1.75x4.75	5	1040	12½	171	1045	N	3.25x2.12	7	7.00x3.75	3.75x2.75	abcdeg	14 mm	Zen	2	2400	28½	48¼	58⅛	56
30	E	Jad	HG	CI	152	1.75x4.75	5	1040	12½	171	1045	N	3.25x2.12	7	3.75x3.00	3.75x2.75	abcdeg	14 mm	Zen	2	2400	28½	48¼	58⅛	57
45	N	......	HG	CI	37	1.09x3.31	3	1045	10¼	50	1045	N	1.87x2.12	3	2.25x3.00	2.18x2.87	Splash	⅞-18	Zen	1	720	22	28	53	58
45	E	SA	HG	Al	132	1.50x5.62	5	3135	14	147	3140	Y	3.00x2.37	5	3.75x4.12	3.75x4.50	abce	⅞-18	Zen	2½	2500	24	46	78	59
45	E	SA	HG	Al	154	1.68x6.25	5	3135	14	147	3140	Y	3.00x2.37	5	3.75x4.12	3.75x4.50	abe	⅞-18	Zen	2½	2700	24	46	78	60
45	E	SA	HG	Al	312	2.25x7.62	5	3135	21	186	3140	Y	4.25x4.00	5	5.00x7.00	5.00x7.00	abce	14 mm	Zen(2)	2½	7000	47	54	132	61
45	E	SA	HG	Al	132	1.50x5.62	5	3135	14	147	3140	Y	3.00x2.37	7	3.75x4.12	3.75x4.50	abe	⅞-18	Zen(2)	2	3000	24	46	94	62
45	E	SA	HG	Al	154	1.68x6.25	5	3135	14	147	3140	Y	3.00x2.37	7	3.75x4.12	3.75x4.50	abe	⅞-18	Zen(2)	2	3200	24	46	94	63
45	E	SA	HG	Al	312	2.25x7.62	5	3135	21	186	3140	Y	4.25x4.00	7	5.00x7.00	5.00x7.00	abce	14 mm	Zen(3)	2½	11600	47	54	160	64
45	E	SA	HG	Al	132	1.50x5.62	5	3135	14	147	3140	Y	3.00x2.37	9	3.75x4.12	3.75x4.50	abe	⅞-18	Zen(2)	2½	4000	24	46	111	65
45	E	SA	HG	Al	154	1.68x6.25	5	3135	14	147	3140	Y	3.00x2.37	9	3.75x4.12	3.75x4.50	abe	⅞-18	Zen(2)	2½	4300	24	46	111	66
45	E	SA	HG	Al	312	2.25x7.62	5	3135	21	186	3140	Y	4.25x4.00	9	5.00x7.00	5.00x7.00	abce	14 mm	Zen(4)	2½	15000	47	54	188	67
30	N	......	HG	CI	35	.864x3.15	3	DFS	6 13/16	31	DFS	Y	2.31x1.5	4	2.69x1.19	2.78x1.62	abcg	10 mm	Car	1¼	550	21	29½	39.19	68
30	N	......	HG	CI	38	.864x3.15	3	DFS	6 13/16	31	DFS	Y	2.31x1.5	4	2.69x1.19	2.78x1.62	abcg	10 mm	Car	1¼	560	21	23¾	39.14	69
30	N	......	HG	Al	21	.750x2.87	3	3140	6 9/16	22	1045	N	1.75x1.12	3	1.98x1.62	1.98x1.62	abr	14 mm	Zen	1¼	456*	24⅛	23 1/16	31 11/16	70
30	N	......	HG	Al	25	.875x2.87	3	1035	7	29	1045	N	1.98x1.12	7	2.49x1.93	2.49x1.37	abr**	14 mm	Zen	1⅜	626*	24⅛	25½	40	71
30	N	......	HG	Al	36	1.00x3.50	3	1040	8	40	1045	N	1.98x1.50	7	2.49x2.12	2.49x1.37	abr	14 mm	Zen	1¾	850*	26 5/16	27 9/32	46 5/16	72
30	N	......	HG	Al	44	1.12x3.68	4	3140	8⅞	52	1045	Y	2.24x1.50	7	2.62x2.75	2.62x1.75	aber	14 mm	Zen	2	1232*	26⅛	29 5/16	53 7/16	73
45	E	CMT	HG	CI	33	.859x2.75	4	1335	7 15/16	33	1040	Y	2.08x1.25	4	2.50x1.24	2.50x1.87	abce	18 mm	Zen	1¼	695	23¾	23 11/16	43⅜	74
45	E	CMT	HG	CI	37	.859x2.87	4	1335	7⅞	35	1040	Y	2.12x1.37	4	2.50x1.31	2.50x1.87	abce	18 mm	ZC	1½	840	23¾	25 11/16	45⅝	75
45	E	CMT	HG	Al	23	.859x2.75	4	1335	9	38	1040	Y	2.18x1.37	5	2.70x1.65	2.70x2.09	abce	18 mm	ZC(2)	1½	1074	28 3/16	28 9/16	54⅝	76
45	E	CMT	HG	Al	23	.859x2.75	4	1335	9	38	1040	Y	2.18x1.37	5	2.70x1.65	2.70x2.09	abce	18 mm	ZC(4)	1½	2705	54⅝	30	63 11/16	77

(For abbreviations see pages 138-139)

American Gasoline

Line Number	Engine Make and Model	Designed for	Number of Cylinders, Bore and Stroke (In.)	Maximum Brake Hp at Specified R.P.M.: With Bare Engine	Maximum Brake Hp at Specified R.P.M.: With Standard Accessories	Piston Displacement (Cu. In.)	Compression Ratio	Maximum Torque at R.P.M. (Lb. Ft.) with or without Accessories	Cylinder Liners—Type	Crankcase—Upper Half Integral with Cylinders	Valves: Arrangement	Valves: Exhaust Head Material (S.A.E. No.)	Valves: Max. Head Diameter (In.) Intake	Valves: Max. Head Diameter (In.) Exhaust	Valves: Min. Port Diameter (In.) Intake	Valves: Min. Port Diameter (In.) Exhaust	Valves: Lift (In.) Intake	Valves: Lift (In.) Exhaust	Valves: Stem Diameter (In.) Intake	Valves: Stem Diameter (In.) Exhaust
1	Climax G4C	Ind	4-4½x5¼	46-1200	44-1200	334.0	4.75	216-800 (EA)	W	In	I	Sil	2.00	2.00	1.75	1.75	.406	.406	.375	.375
2	Climax H4B	Ind	4-5⅛x6¼	73-1200	68-1200	516.0	4.10	340-800 (EA)	W	In	I	Sil	2.37	2.37	2.12	2.12	.437	.437	.437	.437
3	Climax N4B	Ind	4-5¾x6½	102-1200	90-1200	675.0	4.30	490-700 (EA)	N	In	I	Sil	2.50	2.50	2.25	2.25	.500	.500	.562	.562
4	Climax R4I	Ind	4-6x7	123-1200	112-1200	791.6	4.70	525-750 (EA)	N	Se	I	Sil	2.50	2.50	2.25	2.25	.500	.500	.562	.562
5	Climax R6I	Ind	6-6x7	183-1200	165-1200	1187.4	4.70	802-700 (EA)	N	Se	I	CNS	2.50	2.50	2.25	2.25	.500	.500	.562	.562
6	Climax R8I	Ind	8-6x7	245-1200	221-1200	1583.2	4.70	1085-750 (EA)	N	Se	I	Sil	2.50	2.50	2.25	2.25	.500	.500	.562	.562
7	Climax AV12A	Ind	12-6½x7	425-1200	380-1200	2787.0	4.90	2120-750	W	Se	I	Sil	2.81	2.68	2.50	2.37	.687	.687	.562	.562
8	Climax AV12B	Ind	12-7x7	495-1200	445-1200	3232.0	4.90	2460-750	W	Se	I	Sil	2.81	2.68	2.50	2.37	.687	.687	.562	.562
9	Continental Y-4069	C,Tr,Ind	4-2½x3½	28-3500	....	68.7	6.15	52-2000 (BE)	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.313
10	Continental Y-4091	C,Tr,Ind	4-2⅞x3½	37-3500	....	90.9	6.00	70-1800 (BE)	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.313
11	Continental Y-4112	C,Tr,Ind	4-3$\frac{3}{16}$x3½	46-3400	....	111.7	6.00	87-1800 (BE)	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.313
12	Continental F-4124	C,T,Tr,Ind	4-3x4⅜	48-3400	....	123.7	6.00	94-1800 (BE)	N	In	L	Sil	1.51	1.32	1.37	1.18	.281	.280	.341	.339
13	Continental F-4140	C,T,Tr,Ind	4-3$\frac{3}{16}$x4⅜	51-3400	....	139.6	6.00	106-1600 (BE)	N	In	L	Sil	1.51	1.32	1.37	1.18	.281	.280	.341	.339
14	Continental F-4162	C,T,Tr,Ind	4-3$\frac{7}{16}$x4⅜	58-3200	....	162.4	5.75	124-1600 (BE)	N	In	L	Sil	1.51	1.32	1.37	1.18	.281	.280	.341	.339
15	Continental F-6186	C,T,Tr,Ind	6-3x4⅜	64-3400	....	185.6	6.40	138-1400 (BE)	N	In	L	XCR	1.51	1.32	1.37	1.18	.281	.281	.341	.339
16	Continental F-6209	C,T,Tr,Ind	6-3$\frac{3}{16}$x4⅜	71-3200	....	209.5	5.75	155-1200 (BE)	N	In	L	Sil	1.51	1.32	1.37	1.18	.284	.284	.341	.339
17	Continental F-6226	C,T,Tr,Ind	6-3$\frac{5}{16}$x4⅜	76-3000	....	226.0	6.00	170-1200 (BE)	N	In	L	XCR	1.51	1.32	1.37	1.18	.281	.281	.341	.339
18	Continental M-6271	T,B,Tr,Ind	6-3⅝x4⅜	92-3000	....	270.9	5.75	207-1200 (BE)	N	In	L	Sil	1.76	1.51	1.62	1.37	.354	.354	.404	.402
19	Continental M-6290	T,B,Tr,Ind	6-3¾x4⅜	99-3000	....	289.9	5.70	225-1200 (BE)	N	In	L	Sil	1.76	1.51	1.62	1.37	.354	.354	.404	.402
20	Continental M-6330	T,B,Tr,Ind	6-4x4⅜	107-2800	....	329.8	5.50	258-1000 (BE)	N	In	L	Sil	1.76	1.51	1.62	1.37	.354	.354	.404	.402
21	Continental B-6371	T,B,Ind	6-4⅛x4⅝	109-2600	....	370.9	5.74	280-1000 (BE)	N	In	L	St	1.89	1.64	1.75	1.50	.354	.354	.435	.432
22	Continental B-6405	T,B,Ind	6-4$\frac{5}{16}$x4⅝	115-2600	....	405.3	5.74	314-1000 (BE)	N	In	L	St	1.89	1.64	1.75	1.50	.354	.354	.435	.432
23	Continental 22R	T,B,Ind	6-4½x5¼	141-2400	....	501.0	4.50	375-1000 (BE)	N	In	I	AUS	2.06	1.87	1.81	1.62	.420	.420	.435	.433
24	Continental R6572	T,B,M,Ind	6-4¾x5⅜	175-2750	....	571.7	6.25	436-1250 (BE)	N	In	I	St	2.14	1.89	2.00	1.75	.500	.500	.500	.495
25	Continental R6602	T,B,M,Ind	6-4⅞x5⅜	184-2600	....	601.9	6.00	460-1200 (BE)	N	In	I	St	2.14	1.89	2.00	1.75	.500	.500	.500	.495
26	Continental B6427	T,B,M,Ind	6-4$\frac{5}{16}$x4⅞	121-2500	....	427.2	6.60	332-900 (BE)	N	In	L	St	1.89	1.64	1.75	1.50	.354	.354	.435	.432
27	Continental R6513	T,B,M,Ind	6-4½x5⅜	165-2600	....	512.9	5.90	400-1200 (BE)	N	In	I	St	2.14	1.89	2.00	1.75	.500	.500	.500	.491
28	G. M. C. 228	T, B	6-3$\frac{9}{16}$x3$\frac{13}{16}$	95-3200	85-3000	228.0	6.75	178-1000 (EA)	N	In	I	Sil	1.64	1.47	1.25	1.16	.289	.307	.343	.343
29	G. M. C. 248	T, B	6-3$\frac{23}{32}$x3$\frac{13}{16}$	100-3100	89-3000	248.5	6.75	195-1000 (EA)	N	In	I	Sil	1.64	1.47	1.25	1.16	.289	.307	.343	.343
30	G. M. C. 270	T	6-3$\frac{25}{32}$x4	104-3000	95-3000	270.0	6.75	216-1000 (EA)	N	In	I	Sil	1.64	1.47	1.25	1.16	.289	.307	.343	.343
31	G. M. C. 278	T	6-3⅝x4½	100-2800	86-2800	278.6	6.00	213-1000 (EA)	N	Se	I	CHS	1.81	1.56	1.44	1.37	.333	.333	.375	.375
32	G. M. C. 308	T, B	6-3$\frac{13}{16}$x4½	111-2800	87-2800	308.2	6.00	239-800 (EA)	N	Se	I	CHS	1.81	1.46	1.44	1.37	.333	.333	.375	.375
33	G. M. C. 361	T	6-4⅛x4½	122-2800	106-2500	360.8	6.00	265-800 (EA)	N	Se	I	CHS	1.94	1.72	1.50	1.50	.406	.406	.375	.375
34	G. M. C. 426	T	6-4¼x5	145-2600	127-2400	425.6	6.00	322-1000 (EA)	N	Se	I	CHS	1.94	1.72	1.50	1.50	.406	.406	.375	.375
35	G. M. C. 451	T, B	6-4⅜x5	149-2600	130-2400	450.9	6.00	350-1000 (EA)	N	Se	I	CHS	1.94	1.72	1.50	1.50	.406	.406	.375	.375
36	G. M. C. 477	T, B	6-4½x5	153-2600	135-2400	477.1	6.00	365-1000 (EA)	N	Se	I	CHS	1.94	1.72	1.50	1.50	.406	.406	.375	.375
37	G. M. C. 529	B	6-4⅝x5¼	158-2500	144-2300	529.2	5.50	387-1000 (EA)	N	Se	I	CHS	2.12	1.94	1.66	1.62	.406	.406	.437	.437
38	G. M. C. 707	B	6-5x6	175-2200	160-2100	706.8	4.83	555-1000 (EA)	D	Se	I	CHS	2.44	2.17	1.75	1.75	.413	.413	.437	.500
39	Gray Light Four	M	4-2½x3½	....	16-1800	69.0	5.50	....	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.312
40	Gray Sea Scout	M	4-2⅞x3½	....	37-3000	91.0	6.50	....	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.312
41	Gray Phantom 4-45	M	4-2⅞x3½	....	45-3600	91.0	7.50	....	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.312
42	Gray Racing-91	M	4-2⅞x3½	....	65-5000	91.0	9.20	....	N	In	L	Sil	1.32	1.23	1.16	1.07	.284	.284	.314	.312
43	Gray Racing-100	M	4-2$\frac{15}{16}$x3⅝	....	75-5000	98.0	10.00	....	N	In	L	Sil	1.32	1.23	1.16	1.07	.284	.284	.314	.312
44	Gray Four-22	M	4-3$\frac{3}{16}$x3½	....	45-3000	112.0	6.50	....	N	In	L	Sil	1.20	1.01	1.06	.875	.291	.292	.314	.312
45	Gray Four-40	M	4-3$\frac{3}{16}$x4⅜	....	55-3000	140.0	5.50	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.331	.331	.340	.338
46	Gray Phantom 4-62	M	4-3$\frac{3}{16}$x4⅜	....	62-3600	140.0	7.20	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.331	.331	.340	.338
47	Gray Four-52	M	4-3$\frac{7}{16}$x4⅜	....	57-2600	162.0	6.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.331	.331	.340	.338
48	Gray Phantom 4-75	M	4-3$\frac{7}{16}$x4⅜	....	75-3600	162.0	7.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.331	.331	.340	.338
49	Gray Phantom 4-86	M	4-3$\frac{7}{16}$x4⅜	....	86-3600	162.0	8.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.331	.331	.340	.338
50	Gray Six-51	M	6-3¼x4	....	73-3200	199.0	6.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.284	.284	.314	.312
51	Gray Six-71	M	6-3¼x4⅜	....	84-3000	218.0	6.50	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.284	.284	.314	.312
52	Gray Phantom 6-90	M	6-3¼x4⅜	....	90-3600	218.0	7.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.284	.284	.314	.312
53	Gray Phantom 6-103	M	6-3¼x4⅜	....	103-3600	218.0	7.00	....	N	In	L	Sil	1.51	1.32	1.37	1.18	.284	.284	.314	.312
54	Gray Six-91	M	6-3$\frac{7}{16}$x4⅜	....	100-3000	244.0	7.00	....	N	In	L	Sil	1.70	1.43	1.56	1.31	.375	.375	.372	.370
55	Gray Phantom 6-125	M	6-3$\frac{7}{16}$x4⅜	....	125-3600	244.0	7.00	....	N	In	L	Sil	1.70	1.43	1.56	1.31	.375	.375	.372	.370
56	Gray Fireball 6-140	M	6-3$\frac{7}{16}$x4⅜	....	140-4000	244.0	7.50	....	N	In	L	Sil	1.57	1.42	1.43	1.31	.311	.311	.339	.338
57	Gray Fireball 6-150	M	6-3$\frac{7}{16}$x4⅜	....	150-4000	244.0	7.50	....	N	In	L	Sil	1.57	1.42	1.43	1.31	.311	.311	.339	.338
58	Gray Fireball 6-160	M	6-3$\frac{7}{16}$x4⅜	....	160-4000	244.0	7.50	....	N	In	L	Sil	1.57	1.42	1.43	1.31	.311	.311	.339	.338
59	Gray Racing Fireball	M	6-3.30x4⅜	....	180-5000	225.0	10.00	....	N	In	L	Sil	1.71	1.58	1.56	1.43	.360	.360	.340	.371
60	Gray Six-101	M	6-3¾x4⅜	....	110-3200	290.0	6.50	....	N	In	L	Sil	1.78	1.51	1.62	1.37	.354	.354	.404	.402
61	Gray Six-121	M	6-4x4⅜	....	124-3200	330.0	6.50	....	N	In	L	Sil	1.76	1.51	1.62	1.37	.354	.354	.404	.402
62	Gray Super Six	M	6-4x4⅜	....	145-3200	330.0	6.50	....	N	In	L	Sil	1.76	1.51	1.62	1.37	.354	.354	.404	.402
63	Gray Six-105	M	6-4¼x4½	....	101-2400	383.0	5.50	....	N	In	L	Sil	2.06	1.87	1.81	1.62	.406	.406	.434	.432
64	Hall-Scott 130	T, B, FA	6-4¼x5	130-3000	107-2800	425.6	4.96	288-1000 (BE)	W	In	I	2112	2.28	2.16	2.12	1.90	.421	.421	.435	.435
65	Hall-Scott 135	T, B, FA	6-4½x5	145-2800	122-2800	477.1	5.50	340-1000 (BE)	W	In	I	2112	2.28	2.16	2.12	1.90	421	.421	.435	.435
66	Hall-Scott 180	T, B, FA	6-5x6	200-2200	170-2100	706.8	5.16	500-1400 (BE)	W	In	I	2112	2.62	2.37	2.37	2.00	.482	.482	.497	.528
67	Hall-Scott 190	T,B,FA,RC	6-5¼x6	240-2200	200-2000	779.3	5.00	570-1200 (BE)	W	In	I	2112	2.62	2.37	2.37	2.00	.482	.482	.497	.528
68	Hall-Scott 400	T	6-5¾x7	286-1800	260-1800	1090.0	5.70	865-1200 (BE)	N	Se	I	2112	2.87	2.75	2.62	2.50	.482	.482	.497	.528
69	Hall-Scott Invader 186-87	M	6-5½x7	....	252-2100	997.8	5.09	....	N	In	I	2112	2.87	2.87	2.62	2.62	.482	.482	.497	.528
70	Hall-Scott Invader 168-69	M	6-5½x7	....	275-2100	997.8	5.09	....	N	In	I	2112	2.87	2.87	2.62	2.62	.482	.482	.497	.528
71	Hall-Scott Defender 1268-69	M	12-5½x7	....	575-2100	1996.0	5.80	....	N	Se	I	2112	2.87	2.75	2.62	2.50	.482	.482	.497	.528
72	Hall-Scott Defender 2286-87	M	12-5¾x7	....	605-2100	2181.0	7.00	....	N	Se	I	2112	2.87	2.75	2.62	2.50	.482	.482	.497	.528
73	Hall-Scott Defender 2268-69	M	12-5¾x7	....	630-2100	2181.0	7.00	....	N	Se	I	2112	2.87	2.75	2.62	2.50	.482	.482	.497	.528
74	Hall-Scott Defender ‡3368-69	M	12-5¾x7	....	900-2100	2181.0	6.00	....	N	Se	I	2112	2.87	2.75	2.62	2.50	.482	.482	.497	.528
75	Hercules BXB	M, Tr, Ind	2-2⅞x3	10-2300	8-2300	39.0	6.00	28-1250 (BE)	N	In	L	AUS	1.30	1.05	1.12	.875	.200	.200	.248	.248
76	Hercules NXB	M, Tr, Ind	2-3¼x4	16-2000	13-2000	66.3	5.50	46-1100 (BE)	N	In	L	AUS	1.30	1.05	1.12	1.12	.250	.250	.312	.312
77	Hercules ZXB	T,Tr,M,Ind	4-2⅝x3	25-3800	21-3800	64.9	6.10	40-2000 (BE)	N	In	L	AUS	1.30	1.05	1.12	.875	.200	.200	.248	.248
78	Hercules IXF-3	T,Tr,M,Ind	4-2¾x4	33.5-3200	28.5-3200	95.0	5.50	65-2000	N	In	L	CNS	1.48	1.35	1.25	1.12	.250	.250	.310	.310
79	Hercules IXA-3, IXA-5	T,Tr,M,Ind	4-3x4	40-3200	34-3200	113.0	5.50	79-2000 (BE)	N	In	L	AUS	1.48	1.35	1.25	1.12	.250	.250	.310	.310
80	Hercules IXK-3	T,Tr,M,Ind	4-3⅛x4	43-3200	37-3200	122.9	5.50	86-2000 (BE)	N	In	L	AUS	1.48	1.35	1.25	1.12	.250	.250	.310	.310
81	Hercules IXB-3, IXB-5	T,Tr,M,Ind	4-3¼x4	47-3200	40-3200	133.0	5.20	92-2000 (BE)	N	In	L	AUS	1.48	1.35	1.25	1.12	.250	.250	.310	.310
82	Hercules JXB	T,B,Tr,M,Ind	6-3⅝x4¼	84-3000	71.4-3000	263.0	5.40	195-1000	N	In	L	CNS	1.75	1.62	1.50	1.37	.356	.356	.373	.373
83	Hercules JXC	T,B,Tr,M,Ind	6-3¾x4¼	87-3000	74-3000	282.0	5.90	215-1000 (BE)	N	In	L	AUS	1.75	1.62	1.50	1.37	.356	.356	.373	.373
84	Hercules JXD	T,B,Tr,M,Ind	6-4x4¼	110-3000	93-3000	320.0	6.50	243-1200 (BE)	N	In	L	AUS	1.75	1.62	1.50	1.37	.356	.356	.373	.373
85	Hercules WXLC	T,B,Tr,M,Ind	6-4x4¾	111-2800	94-2800	358.0	6.29	268-1100 (BE)	N	In	L	AUS	1.75	1.75	1.62	1.50	.388	.388	.373	.373
86	Hercules WXLC-3	T,B,Tr,M,Ind	6-4¼x4¾	126-2800	107-2800	404.0	6.29	302-1000 (BE)	N	In	L	AUS	1.75	1.75	1.62	1.50	.388	.388	.373	.373
87	Hercules RXC	T,B,Tr,M,Ind	6-4⅝x5¼	131-2400	111-2400	529.2	5.41	395-1000 (BE)	N	In	L	Sil	2.00	2.00	1.75	1.75	.388	.388	.373	.378
88	Hercules RXLD	T,B,Tr,M,Ind	6-4¾x5¼	152-2400	129-2400	558.0	6.20	438-1000 (BE)	N	In	L	AUS	2.00	2.00	1.81	1.75	.388	.388	.373	.373
89	Hercules HXB	T,B,Tr,M,Ind	6-5x6	160-2100	136-2100	707.0	5.75	502-900 (BE)	N	Se	L	Sil	2.43	2.31	2.12	2.00	.468	.468	.498	.493
90	Hercules HXC	T,B,Tr,M,Ind	6-5¼x6	177-2100	150-2100	779.0	5.69	550-1000 (BE)	N	Se	L	Sil	2.43	2.31	2.12	2.00	.468	.468	.498	.498

(For abbreviations see pages 138-139)

Engines—*Continued*

VALVES — Seats — Angle (Deg.)	VALVES — Seats — Inserts Used?	VALVES — Seats — Insert Material (S.A.E. No.)	Camshaft Drive—Type	PISTONS — Material	PISTONS — Weight with Pins, Rings, Bushings (Oz.)	PISTONS — Piston Pin—Diameter and Length (In.)	Number of Rings per Piston	CONNECTING RODS — Material	CONNECTING RODS — Center to Center Length (In.)	CONNECTING RODS — Weight with Bushing and Cap (Oz.)	CRANKSHAFT — Material	CRANKSHAFT — Counter Balance Used	CRANKSHAFT — Crank-Pin — Diameter and Length (In.)	CRANKSHAFT — MAIN BEARINGS — Number	CRANKSHAFT — MAIN BEARINGS — Diameter and Length (In.) — Front	CRANKSHAFT — MAIN BEARINGS — Diameter and Length (In.) — Rear	Oil Pressure to—	Spark Plug—Thread Size	CARBURETOR — Make	CARBURETOR — Size	Engine Weight without Carburetor or Ignition (Lb.)	OVERALL DIMENSIONS (In.) — Width	OVERALL DIMENSIONS (In.) — Height	OVERALL DIMENSIONS (In.) — Length	Line Number
45	E	CI	HG	CI	85	1.31x4.06	4	1045	10½	167	1045	N	2.37x2.12	3	2.37x2.31	2.37x2.75	abcdeg	⅞-18	Zen	1¼	825	25¾	37	41¼	1
45	E	CI	HG	CI	142	1.50x4.31	4	1045	11¾	139	1045	N	2.75x2.50	3	3.00x2.87	3.00x3.62	abcdeg	⅞-18	Zen	1½	1350	28¾	43	47¾	2
45	E	CI	HG	CI	189	1.48x5.25	4	1035	14	194	1045	N	3.00x3.00	3	3.25x3.50	3.25x4.75	abceg	⅞-18	Zen	1¾	1800	30½	46	53¼	3
45	E	CI	HG	Al	153	1.49x5.37	4	3135	16	244	4140	N	3.00x3.50	3	3.25x3.81	3.25x4.50	abceg	⅞-18	Zen	2	2300	31 5/16	49½	57 9/16	4
45	E	CI	HG	Al	153	1.49x5.37	4	3135	16	244	4140	Y	3.00x3.50	4	3.25x3.81	3.25x4.50	abceg	⅞-18	Zen(2)	1¾	3200	29⅛	51⅜	73 11/16	5
45	E	CI	HG	Al	153	1.49x5.37	4	3135	16	244	4140	N	3.37x3.18	5	4.00x3.62	4.00x4.50	abceg	⅞-18	Zen(2)	2	4500	35 5/16	56 11/16	97⅞	6
45	E	NCI	HG	Al	165	2.00x5.75	5	3135	16	276	4140	N	4.00x5.00	7	4.50x3.75	4.50x5.50	abcdeg	18 mm	Zen(4)	2	11000	51	55	95	7
45	E	NCI	HG	Al	176	2.00x5.75	5	3135	16	276	4140	N	4.00x5.00	7	4.50x3.75	4.50x5.50	abcdeg	18 mm	Zen(4)	2	11200	51	55	95	8
(h)	N	......	HG	CT	.....	.703x2.06	3	1030	5¾	.....	1045	N	1.50x1.18	3	1.75x1.37	1.75x1.78	abcet	18 mm	......	⅞	298	26	22 11/16	25½	9
(h)	N	......	HG	CT	.....	.703x2.44	3	1030	5¾	.....	1045	N	1.50x1.18	3	1.75x1.37	1.75x1.78	abcet	18 mm	......	⅞	305	26	22 11/16	25½	10
(h)	N	......	HG	CT	.....	.703x2.75	3	1030	5¾	.....	1045	N	1.50x1.18	3	1.75x1.28	1.75x1.65	abcet	18 mm	......	1	315	26	22 11/16	25½	11
(h)	E	WA	HG	CT	.....	.859x2.50	4	1030	7	.....	1045	N	1.93x1.31	3	2.25x1.18	2.25x1.89	abcet	18 mm	......	1¼	400	26	26 11/32	29 7/16	12
(h)	E	WA	HG	CT	.....	.859x2.68	4	1030	7	.....	1045	N	1.93x1.31	3	2.25x1.18	2.25x1.89	abcet	18 mm	......	1¼	405	26	26 11/32	29 7/16	13
(h)	E	WA	HG	CT	.....	.859x2.87	4	1030	7	.....	1045	N	1.93x1.31	3	2.25x1.18	2.25x1.89	abcet	18 mm	......	1¼	410	26	26 11/32	29 7/16	14
(h)	E	WA	Ch	CT	.....	.859x2.50	4	1030	7	.....	1045	Y	1.93x1.31	4	2.25x1.18	2.25x1.81	abcet	18 mm	......	1¼	481	26	27¼	36 11/32	15
(h)	E	WA	Ch	CT	.....	.859x2.62	4	1030	7	.....	1045	Y	1.93x1.31	4	2.25x1.21	2.25x1.81	abcet	18 mm	......	1¼	506	26	27¼	36 11/32	16
(h)	E	WA	Ch	CT	.....	.859x2.62	4	1030	7	.....	1045	Y	2.06x1.31	4	2.37x1.28	2.37x1.73	abcet	18 mm	......	1¼	512	26	27¼	36 11/32	17
(h)	E	WA	HG	CT	.....	1.10x3.06	4	1035	8⅜	.....	1045	Y	2.25x1.56	7	2.62x1.56	2.62x2.18	abcet	18 mm	......	1½	750	25¾	29½	42	18
(h)	E	WA	HG	CT	.....	1.10x3.18	4	1035	8⅜	.....	1045	Y	2.25x1.56	7	2.62x1.56	2.62x2.18	abcet	18 mm	......	1½	760	25¾	29½	42	19
(h)	E	WA	HG	CT	.....	1.10x3.43	4	1035	8⅜	.....	1045	Y	2.25x1.56	7	2.62x1.56	2.62x2.18	abcet	18 mm	......	1½	770	25¾	29½	42	20
(k)	E	HS	HG	Al	.....	1.25x3.43	5	1035	8⅜	.....	1045	Y	2.50x1.69	7	2.87x1.65	2.87x2.72	abcet	18 mm	......	1¾	855	26	29¼	43 11/32	21
(k)	E	HS	HG	Al	.....	1.25x3.43	5	1035	8⅜	.....	1045	Y	2.50x1.69	7	2.87x1.65	2.87x2.72	abcet	18 mm	......	1¾	870	26	29¼	43 11/32	22
30	E	HS	Ch	Al	.....	1.50x3.71	4	1035	10½	.....	4140	Y	2.75x1.81	7	2.75x1.75	2.75x2.81	abcefg	18 mm	......	2	1430	25¾	39⅝	46 11/32	23
(h)	E	Tun	HG	Al	.....	1.50x3.72	5	1035	10½	.....	1045	Y	3.00x1.94	7	3.25x1.75	3.25x2.75	abcegt	18 mm	......	2	1250	29	43 11/32	51 9/32	24
(h)	E	Tun	HG	Al	.....	1.50x3.72	5	1035	10½	.....	1045	Y	3.00x1.94	7	3.25x1.75	3.25x2.75	abcegt	18 mm	......	2	1250	29	43 11/32	51 9/32	25
(h)	E	Tun	HG	Al	.....	1.25x3.43	5	1035	8⅜	.....	1045	Y	2.50x1.69	7	2.87x1.65	2.87x2.71	abcegt	18 mm	......	1¾	885	26	29¼	43 11/32	26
(h)	E	Tun	HG	Al	.....	1.50x3.72	5	1035	10½	.....	1045	Y	3.00x1.94	7	3.25x1.75	3.25x2.75	abceg	18 mm	......	2	1250	29	43 11/32	51 9/32	27
30	E	WR	HG	Al	33	.990x3.08	4	1040-A	7	33	1050	Y	2.31x1.23	4	2.69x1.19	2.78x1.47	abcdeg	14 mm	Zen	1⅜	......	21 11/16	26 1/16	40¾	28
30	E	WR	HG	Al	34	.990x3.25	4	1040-A	7	33	1050	Y	2.31x1.23	4	2.69x1.19	2.78x1.47	abcdeg	14 mm	Zen	1⅜	......	21 11/16	26 1/16	40¾	29
30	E	WR	HG	Al	34	.990x3.25	4	1040-A	7	33	1050	Y	2.31x1.23	4	2.69x1.19	2.78x1.47	abcdeg	14 mm	Zen	1⅜	......	21 11/16	26 1/16	40¾	30
45	E	WR	HG	Al	37	1.00x3.18	4	1040-A	9¾	51	1050	Y	2.37x1.34	7	2.75x2.09	2.75x2.09	abcdeg	14 mm	Zen	1⅜	......	25¼	31 21/32	45 1/32	31
45	E	WR	HG	Al	40	1.00x3.36	4	1040-A	9¾	51	1050	Y	2.37x1.34	7	2.75x2.09	2.75x2.09	abcdeg	14 mm	Zen	1⅜	......	25¼	31 21/32	45 1/32	32
(h)	E	St	HG	Al	59	1.25x3.59	4	1040-A	10¾	73	1050	Y	2.62x1.47	7	3.00x2.22	3.00x2.22	abcdeg	14 mm	Zen	1½	......	22½	35 3/16	47 11/16	33
(h)	E	St	HG	Al	60	1.25x3.71	4	1040-A	10¾	73	1050	Y	2.62x1.47	7	3.00x2.22	3.00x2.22	abcdeg	14 mm	Zen	1½	......	22½	35 3/16	47 11/16	34
(h)	E	St	HG	Al	63	1.25x3.84	4	1040-A	10¾	73	1050	Y	2.62x1.47	7	3.00x2.22	3.00x2.22	abcdeg	14 mm	Zen	1¾	......	22½	35 3/16	47 11/16	35
(h)	E	St	HG	Al	64	1.25x3.96	4	1040-A	10¾	.....	1050	Y	2.62x1.75	7	3.00x2.22	3.00x2.22	abcdeg	14 mm	Zen	1¾	......	22½	35 3/16	47 11/16	36
30	E	St	HG	Al	66	1.25x4.06	4	1040-A	10½	82	1050	Y	2.62x1.72	7	3.50x2.50	3.50x2.50	abcdeg	14 mm	Zen	2	......	27	47	50	37
30	E	St	HG	Al	77	1.37x4.47	5	4140-A	12⅛	77	4140	Y	2.75x2.06	7	3.00x1.72	3.00x2.50	abcdeg	18 mm	Str	2	......	29½	50	62½	38
(h)	N	......	HG	CI	16	.703x2.06	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.78	1.75x1.37	abce	14 mm	Zen	¾	330	16¼	17½	30	39
(h)	N	......	HG	CI	21	.703x2.43	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.78	1.75x1.37	abce	14 mm	Zen	1	375	15	18⅝	30⅝	40
(h)	N	......	HG	Al	16	.703x2.43	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.78	1.75x1.37	abce	14 mm	Zen	1⅜	340	17⅜	18½	30	41
(h)	N	......	HG	Al	16	.703x2.43	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.78	1.75x1.37	abce	14 mm	Zen	1	265	21⅜	22 7/16	24½	42
(h)	N	......	HG	Al	16	.703x2.43	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.78	1.75x1.37	abce	14 mm	Zen	1	260	21⅜	22 7/16	24½	43
(h)	N	......	HG	CI	25	.709x2.68	3	CS	5¾	17	1045	N	1.50x1.18	3	1.75x1.66	1.75x1.28	abce	14 mm	Zen	1	410	15	18⅝	31⅝	44
(h)	N	......	HG	Al	20	.859x2.68	4	CS	7	32	1045	N	1.93x1.31	3	2.25x1.89	2.25x1.18	abce	18 mm	Zen	1¼	510	18 7/16	23½	35⅛	45
(h)	N	......	HG	Al	20	.859x2.68	4	CS	7	32	1045	N	1.93x1.31	3	2.25x1.89	2.25x1.18	abce	18 mm	Zen	1¼	435	20¼	21⅞	33	46
(h)	N	......	HG	Al	24	.859x2.68	4	CS	7	32	1045	N	1.93x1.31	3	2.25x1.89	2.25x1.18	abce	18 mm	Zen	1¼	540	18 7/16	23½	35⅛	47
(h)	N	......	HG	Al	24	.859x2.68	4	CS	7	32	1045	N	1.93x1.31	3	2.25x1.89	2.25x1.18	abce	18 mm	Zen	1¼	460	20¼	21⅞	33	48
(h)	N	......	HG	Al	24	.859x2.68	4	CS	7	32	1045	N	1.93x1.31	3	2.25x1.89	2.25x1.18	abce	18 mm	Zen	1¼	465	22¾	27¾	33	49
(h)	N	......	HG	CI	29	.859x2.68	4	CS	7	32	1045	Y	1.93x1.31	4	2.25x1.81	2.25x1.21	abce	18 mm	Zen	1¼	650	18½	23	41	50
(h)	N	......	HG	CI	31	.859x2.68	4	CS	7	32	1045	Y	1.93x1.31	4	2.25x1.81	2.25x1.21	abce	18 mm	Zen	1½	665	18½	23	42	51
(h)	N	......	HG	Al	20	.859x2.68	4	CS	7	32	1045	Y	1.93x1.31	4	2.25x1.81	2.25x1.21	abce	18 mm	Zen	1½	625	23	22	39⅞	52
(h)	N	......	HG	Al	20	.859x2.68	4	CS	7	32	1045	Y	1.93x1.31	4	2.25x1.81	2.25x1.21	abce	18 mm	Zen	1¼	630	23	22	39⅞	53
45	N	......	HG	Al	28	.859x2.87	4	CS	8⅜	34	1045	Y	2.12x1.37	5	2.37x2.06	2.37x1.43	abce	18 mm	Zen	1¾	795	22	26⅛	43⅜	54
45	N	......	HG	Al	28	.859x2.87	4	CS	8⅜	34	1045	Y	2.12x1.37	5	2.37x2.06	2.37x1.43	abce	18 mm	Zen	1¾	750	24½	25⅛	42⅞	55
(h)	N	......	HG	Al	28	.859x2.87	4	CS	8⅜	34	1045	Y	2.12x1.37	4	2.37x2.06	2.37x1.43	abce	18 mm	Str	1½	730	22½	30	42¾	56
(h)	N	......	HG	Al	28	.859x2.87	4	CS	8⅜	34	1045	Y	2.12x1.37	4	2.37x2.06	2.37x1.43	abce	18 mm	Str	1½	730	22½	30	42¾	57
(h)	N	......	HG	Al	28	.859x2.87	4	CS	8⅜	34	1045	Y	2.12x1.37	4	2.37x2.06	2.37x1.43	abce	18 mm	Zen	1½	730	30¾	32½	42¾	58
45	N	......	HG	Al	25	.874x2.92	4	CS	8⅜	32	1045	Y	2.12x1.37	4	2.39x1.91	2.39x1.50	abce	18 mm	Zen	1½	595	28⅝	23	38⅞	59
(h)	N	......	HG	Al	40	1.10x3.18	4	CS	8⅜	47	1045	Y	2.25x1.56	7	2.62x2.15	2.62x1.56	abce	18 mm	Str	1½	985	23 11/16	28	49⅝	60
(h)	N	......	HG	Al	45	1.10x3.43	4	CS	8⅜	47	1045	Y	2.25x1.56	7	2.62x2.15	2.62x1.56	abce	18 mm	Str	1¾	1015	23 11/16	28	49⅝	61
(h)	N	......	HG	Al	45	1.10x3.43	4	CS	8⅜	47	1045	Y	2.25x1.56	7	2.62x2.15	2.62x1.56	abce	18 mm	Str	1½	990	23 11/16	28	49	62
30	E	HS	HG	CI	74	1.25x3.43	4	CS	9	60	1045	Y	2.37x1.81	7	2.62x2.65	2.62x1.65	abce	18 mm	Str	1½	1250	22	29⅛	55⅝	63
30	E	CA	Ch	Al	52	1.12x3.74	4	AS	11	104	4140	Y	2.62x2.00	7	3.00x1.50	3.00x2.25	abcefg	18 mm	Zen	1¾	1252*	54¾	18 7/16	52⅞	64
30	E	CA	Ch	Al	56	1.12x3.98	4	AS	11	104	4140	Y	2.62x2.00	7	3.00x1.50	3.00x2.25	abcefg	18 mm	Zen	1¾	1265*	54¾	18 7/16	52⅞	65
30	E	CA	Ch	Al	77	1.37x4.20	5	AS	11	119	4140	Y	2.75x2.45	7	3.00x2.18	3.25x2.56	abcefg	18 mm	Zen	2	1960*	53 1/16	20 11/16	69⅜	66
30	E	CA	HC	Al	104	1.37x4.43	5	AS	11	119	4140	Y	2.75x2.45	7	3.25x2.18	3.25x2.56	abcefg	18 mm	Zen(2)	1¾	2035*	53½	22¼	69⅜	67
(h)	E	4140°	HC	Al	120	1.37x4.93	6	3140	12	157	4140	Y	3.00x2.43	7	3.25x2.09	3.25x3.12	abceg	18 mm	Zen	2½	1950*	28	44⅝	60 9/16	68
30	N	......	Ch	Al	108	1.37x4.68	5	AS	11	117	4140	Y	2.50x2.45	7	2.75x1.94	2.75x1.94	abcefg	18 mm	Zen(2)	2	3265*	25	47⅛	90½	69
30	N	......	Ch	Al	108	1.37x4.68	5	AS	11	117	4140	Y	2.50x2.45	7	2.75x1.94	2.75x1.94	abcefgr	18 mm	Zen(2)	2	2200*	25	39⅝	74 3/16	70
30	E	CA	HC	Al	101	1.37x4.68	6	3140	12	237‡	4140	Y	3.00x2.43	7	3.25x2.09	3.25x3.09	abcefgr	18 mm	Zen(3)	2½	3650*	45	42¾	88	71
30	E	CA	HC	Al	128	1.37x4.94	6	3140	12	237‡	4140	Y	3.00x2.43	7	3.25x2.09	3.25x2.09	abcefgr	18 mm	Zen(3)	2½	4560*	43¾	50¼	108 1/16	72
30	E	CA	HC	Al	128	1.37x4.94	6	3140	12	237‡	4140	Y	3.00x2.43	7	3.25x2.09	3.25x2.09	abcefgr	18 mm	Zen(3)	2½	3650*	45	42¾	88	73
30	E	CA	HC	Al	123	1.37x4.94	6	3140	12	237‡	4140	Y	3.00x2.43	7	3.25x2.09	3.25x2.09	abcefgr	18 mm	Zen(4)	2½	4105*	43¾	56¼	91 1/16	74
30	N	......	HG	CI	17	.687x2.50	3	3140	5⅛	15	1045	Y	1.50x1.00	2	2.00x1.25	2.00x1.37	abe	14 mm	Op	⅝	131	14⅞	16¼	18 11/16	75
30	N	......	HG	CI	29	.750x2.81	3	3140	6 9/16	21	4140	Y	1.75x1.12	2	2.00x1.56	2.00x1.62	abe	⅞-18	Op	Op	270	15¼	18½	18⅝	75
30	N	......	HG	CI	19	.687x2.31	3	3140	5⅛	15	4140	N	1.50x1.00	3	2.00x1.31	2.00x1.37	abe	14 mm	Op	Op	179	14¾	16 9/16	21 3/16	77
30	N	......	HG	CI	19	.75x2.43	3	3140	6 9/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abe	⅞-18	Op	1¼	275	16⅝	18¾	24 3/16	78
30	N	......	HG	CI	28	.750x2.56	3	3140	6 9/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abe	⅞-18	Op	Op	285	16⅝	18¾	24 3/16	79
30	N	......	HG	CI	29	.750x2.56	3	3140	6 9/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abe	⅞-18	Op	Op	280	16⅝	18¾	24 3/16	80
30	N	......	HG	CI	29	.750x2.81	3	3140	6 9/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abe	⅞-18	Op	Op	293	16⅝	18¾	24 3/16	81
45	N	......	HG	Al	35	1.00x3.15	4	1035	8	37	CS‡	N	2.00x1.50	7	2.50x1.31	2.50x2.12	abe	⅞-18	Op	1¼	560	17⅝	23½	37⅜	82
45	N	......	HG	Al	37	1.00x3.37	4	1035	8	37	CS‡	Op	2.00x1.50	7	2.50x1.31	2.50x2.12	abe	⅞-18	Op	1¼	565	17⅝	23½	37⅜	83
45	N	......	HG	Al	40	1.00x3.51	4	1035	8	37	CS‡	Op	2.00x1.50	7	2.50x1.31	2.50x2.12	abe	⅞-18	Op	1¾	570	17⅝	23½	37⅜	84
45	N	......	HG	Al	47	1.12x3.56	4	3140	8⅞	50	CS‡	Y	2.25x1.50	7	2.62x1.75	2.75x2.75	abe	⅞-18	Op	1¾	811	21	27	41 11/16	85
45	N	......	HG	Al	55	1.12x3.68	4	3140	8⅞	50	CS‡	Y	2.25x1.50	7	2.62x1.75	2.75x2.75	abe	⅞-18	Op	1¾	825	21	27	41 11/16	86
45	N	......	HG	Al	62	1.25x4.06	5	3140	9⅜	81	CS‡	Op	2.62x2.00	7	3.00x1.93	3.00x2.93	abe	⅞-18	Op	1¾	010	21 11/32	31 13/16	45 5/16	87
(h)	N	......	HG	Al	69	1.25x4.10	5	CNM	9⅜	99	CS‡	Op	3.00x2.00	7	3.50x1.93	3.50x2.93	abe	⅞-18	Op	1¾	1195	22 5/16	30	44¾	88
30	E	......	HG	Al	95	1.50x4.43	4	3140	12	143	CS‡	Op	3.00x2.25	7	3.50x2.37	3.50x3.50	abce	⅞-18	Op	2	1810	24½	40½	54½	89
30	E	......	HG	Al	105	1.50x4.56	4	3140	12	143	CS‡	Op	3.00x2.25	7	3.50x2.37	3.50x3.50	abce	⅞-18	Op	2	1810	24½	40½	54½	90

(For abbreviations see pages 138-139)

American Gasoline

Line Number	Engine Make and Model	Designed for	Number of Cylinders, Bore and Stroke (In.)	MAXIMUM BRAKE Hp. at Specified R.P.M.		Piston Displacement (Cu. In.)	Compression Ratio	Maximum Torque at R.P.M. (Lb. Ft.) with or without Accessories	Cylinder Liners—Type	Crankcase—Upper Half Integral with Cylinders	VALVES									
				With Bare Engine	With Standard Accessories						Arrangement	Exhaust Head Material (S.A.E. No.)	Max. Head Diameter (In.) Intake	Max. Head Diameter (In.) Exhaust	Min. Port Diameter (In.) Intake	Min. Port Diameter (In.) Exhaust	Lift (In.) Intake	Lift (In.) Exhaust	Stem Diameter (In.) Intake	Stem Diameter (In.) Exhaust
1	Hercules..........HXD	T,B,Tr,M,Ind	6-5½x6	184-1800	156-1800	855.0	5.73	630-900 (BE)	N	Se	L	Sil	2.43	2.31	2.12	2.00	.468	.468	.498	.498
2	Hercules..........HXE	T,B,Tr,M,Ind	6-5¾x6	200-1800	170-1800	935.0	5.50	695-900 (BE)	N	Se	L	Sil	2.43	2.31	2.12	2.00	.468	.468	.498	.498
3	International..........U-2	Tr,Ind	4-3x4	24-1800	22-1800	113.1	5.23	78-1000 (EA)	W	In	I	CNS	1.34	1.21	1.18	1.06	.261	.261	.341	.341
4	International..........U-4	Tr,Ind	4-3⅜x4¼	33-1800	31-1800	152.1	5.90	108-1250 (EA)	D	In	I	CNS	1.50	1.37	1.34	1.21	.343	.343	.341	.341
5	International..........U-6	Tr,Ind	4-3⅞x5¼	42-1500	41-1500	247.7	5.65	162-900 (EA)	D	In	I	CNS	1.81	1.65	1.59	1.43	.438	.438	.371	.371
6	International..........U-9	Tr,Ind	4-4.4x5½	55.5-1500	54.5-1500	334.5	5.40	228-1000 (EA)	D	In	I	CNS	2.09	1.91	1.87	1.69	.469	.469	.402	.402
7	International..........GRD-233	T	6-3 5/16x4½	93-3400	80-3400	232.6	6.30	176-800 (EA)	In	In	L	Sil	1.68	1.46	1.50	1.34	.320	.320	.372	.372
8	International..........BLD-269	T	6-3 9/16x4½	100-3000	89-2800	269.1	6.30	216-1000 (EA)	D	In	I	Sil	1.65	1.46	1.50	1.31	.332	.332	.342	.342
9	International..........RED-450	T	6-4⅜x5	148-2600	130-2600	451.0	6.30	354-1000 (EA)	D	In	I	Sil	2.25	1.54	2.00	1.43	.449	.449	.434	.434
10	Kermath..........ZX	M	4-2⅝x3	....	25-3400	65.0	6.00	40-1700 (EA)	N	In	L	Sil	1.25	1.12	1.12	.875	.250	.250	.310	.310
11	Kermath..........IXH	M	4-3¼x4	....	60-3600	134.0	5.50	97-2200 (EA)	N	In	L	Sil	1.48	1.35	1.25	1.12	.250	.250	.310	.310
12	Kermath..........KWF	M	4-3⅛x4⅜	....	40-2700	134.0	6.48	106-2200 (EA)	N	In	L	......	1.53	1.46	1.34	1.23	.359	.359	.373	.373
13	Kermath..........KWHS	M	4-3⅛x4⅜	....	61-3600	134.0	6.48	106-2200 (EA)	N	In	L	......	1.53	1.46	1.34	1.28	.359	.359	.373	.373
14	Kermath..........KWSS	M	4-3⅛x4⅜	....	68-3800	134.0	6.48	106-2200 (EA)	N	In	L	......	1.53	1.46	1.34	1.28	.359	.359	.373	.373
15	Kermath..........P-841	M	6-3¼x3¾	....	110-3600	187.0	7.00	....	N	In	L	Sil	1.47	1.34	1.31	1.18	.296	.296	.312	.312
16	Kermath..........QXC	M	6-3⅜x4⅛	....	95-3600	221.0	6.50	....	N	In	L	Sil	1.87	1.87	1.81	1.81	.281	.281	.310	.310
17	Kermath..........P-640	M	6-3 9/16x4	....	103-3800	239.0	7.20	....	N	In	L	Sil	1.59	1.47	1.37	1.31	.296	.296	.312	.312
18	Kermath..........JXD	M	6-4x4¼	....	122-3000	320.0	6.90	235-2000 (EA)	N	In	L	CNS	1.84	1.62	1.62	1.37	.376	.376	.373	.373
19	Kermath..........WXC	M	6-4¼x4½	....	115-2800	383.0	5.80	265-1000 (EA)	N	In	L	Sil	1.87	1.75	1.62	1.50	.358	.356	.373	.373
20	Kermath..........WXL	M	6-4¼x4¾	....	155-3000	404.0	6.50	....	N	In	L	CNS	2.06	1.87	1.81	1.62	.500	.500	.373	.373
21	Kermath..........D	M	6-4⅜x5¾	....	150-2500	520.0	5.70	350-1000 (EA)	N	Se	L	CNS	2.50	2.25	2.28	2.00	.437	.375	.437	.375
22	Kermath..........L	M	6-5x5¾	....	157-2000	678.0	5.30	482-1000(EA)	N	Se	L	CNS	2.56	2.37	2.37	2.12	.375	.375	.437	.437
23	Kermath..........LA	M	6-5x5¾	....	200-2400	678.0	5.70	480-1000 (EA)	N	Se	L	CNS	2.62	2.37	2.40	2.00	.437	.375	.437	.437
24	Kermath..........R	M	6-5x5¾	....	225-2400	678.0	5.70	540-1700 (EA)	N	Se	I	CNS	1.93	1.93	1.76	1.76	.375	.375	.375	.375
25	Kermath..........VF	M	8-3 1/16x3¾	....	85-3800	221.0	6.30	150-2000 (EA)	....	In	L	Sil	1.53	1.53	......	......	.292	.292	.310	.310
26	Kermath..........VM	M	8-3 3/16x3¾	....	95-3800	239.0	6.15	170-2100 (EA)	....	In	L	CNS	1.53	1.53	......	......	.292	.292	.311	.311
27	Kermath..........P-836	M	8-3¼x3½	....	100-3600	232.0	7.00	175-1600 (EA)	N	In	L	Sil	1.37	1.34	1.25	1.19	.328	.328	.312	.312
28	Kermath..........VZ	M	12-2⅞x3¾	....	120-3500	292.0	.....	....	....	In	L	CNS	1.53	1.53	......	......	.292	.292	.311	.311
29	Kermath..........V	M	12-5x6	....	500-2400	1414.0	5.70	1070-1400 (EA)	N	Se	I	CNS	1.93	1.93	1.76	1.76	.375	.375	.437	.437
30	Lathrop..........Standard	M	2-5 3/16x6½	....	16-600	274.7	.....	140-525 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
31	Lathrop..........Standard	M	2-5½x6½	....	20-700	308.8	.....	163-525 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
32	Lathrop..........Standard	M	3-5 3/16x6½	....	27-700	412.1	.....	206-600 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
33	Lathrop..........Standard	M	3-5½x6½	....	34-800	463.2	.....	237-700 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
34	Lathrop..........LH	M	4-3¼x4	....	38-2200	133.0	.....	92-2000 (EA)	N	In	L	CNS	......	......	1.25	1.12	.312	.312	.312	.312
35	Lathrop..........Standard	M	4-5 3/16x6½	....	29-700	549.5	.....	233-500 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
36	Lathrop..........Standard	M	4-5½x6½	....	49-800	617.7	.....	342-600 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
37	Lathrop..........Engineers	M	4-5½x7	....	64-1000	665.2	.....	373-650 (EA)	N	Se	L	CNS	2.68	2.50	2.31	2.12	.375	.375	.500	.500
38	Lathrop..........Engineers	M	4-6x7	....	76-1000	791.6	.....	461-700 (EA)	N	Se	L	CNS	2.68	2.50	2.31	2.12	.375	.375	.500	.500
39	Lathrop..........LH	M	6-3¾x4¼	....	62-2200	282.0	.....	173-550 (EA)	N	In	L	CNS	......	......	1.50	1.37	.312	.312	.375	.375
40	Lathrop..........LH-D6	M	6-4x4¼	....	107-2500	320.0	.....	226-2500 (EA)	N	In	L	CNS	1.75	1.62	1.50	1.37	.356	.356	.375	.375
41	Lathrop..........Mystic	M	6-4½x5½	....	96-1600	524.8	.....	321-1350 (EA)	N	Se	L	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
42	Lathrop..........Mystic	M	6-4¾x5½	....	108-1600	584.7	.....	379-900 (EA)	N	Se	L	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
43	Lathrop..........Standard	M	6-5½x6½	....	73-750	926.5	.....	515-675 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.375	.375	.437	.437
44	Lathrop..........Standard	M	6-5½x6½	....	103-1000	926.5	.....	550-825 (EA)	N	Se	T	CNS	2.25	2.25	2.00	2.00	.500	.500	.437	.437
45	Lathrop..........Mystic	M	6-5½x6½	....	155-1500	926.5	.....	561-1200 (EA)	N	Se	L	CNS	2.68	2.68	2.31	2.31	.437	.437	.500	.500
46	Lathrop..........Mystic	M	6-5¾x6½	....	179-1600	1012.8	.....	640-1100 (EA)	N	Se	L	CNS	2.68	2.68	2.31	2.31	.437	.437	.500	.500
47	Le Roi..........X	Ind	4-2⅞x3½	....	18-1800	90.8	4.75	50.5-1200	N	In	L	Sil	1.43	1.43	1.06	1.06	.187	.187	.312	.312
48	Le Roi..........D140	Ind	4-3½x3⅝	....	33-2300	140.0	5.85	94.5-1200	W	In	I	CNS	1.37	1.28	1.18	1.18	.311	.311	.342	.342
49	Le Roi..........D176	Ind	4-3¾x4	....	38-1800	176.0	5.40	122-1200	W	In	I	CNS	1.68	1.50	1.37	1.25	.373	.373	.372	.372
50	Le Roi..........D226	Ind	4-4x4½	....	51-2000	226.0	4.71	167-1200	W	In	I	CNS	1.68	1.50	1.37	1.25	.373	.373	.372	.372
51	Le Roi..........D201	Ind	4-4x4	....	44-1800	201.0	4.87	140-1200	W	In	I	CNS	1.68	1.50	1.37	1.25	.373	.373	.372	.372
52	Le Roi..........D318	Ind	4-4½x5	....	46-1200	318.0	4.60	204-900	W	In	I	CNS	1.87	1.75	1.75	1.62	.470	.470	.433	.433
53	Le Roi..........D382	Ind	4-4½x6	....	57-1200	382.0	4.60	257-....	W	In	I	......	1.87	1.75	1.75	1.62	.470	.470	.433	.433
54	Le Roi..........D471	Ind	4-5x6	....	70-1200	471.0	4.50	320-900	W	In	I	CNS	1.87	1.75	1.75	1.62	.470	.470	.433	.433
55	Le Roi..........RXI	Ind	4-6¾x7	....	140-1200	1002.0	4.50	690-650	N	Se	I	Sil	2.81	2.81	2.12	2.50	.590	.590	.624	.624
56	Le Roi..........RXIS	Ind	6-6¾x7	....	208-1200	1503.0	4.50	1035-650	N	Se	I	Sil	2.81	2.81	2.12	2.50	.590	.590	.624	.624
57	Le Roi..........RXIV	Ind	8-6¾x7	....	278-1200	2004.0	4.50	1380-650	N	Se	I	Sil	2.81	2.81	2.12	2.50	.590	.590	.624	.624
58	Le Roi..........RXISV	Ind	12-6¾x7	....	416-1200	3006.0	.....	2075-650	N	Se	I	Sil	2.81	2.81	2.12	2.50	.590	.590	.624	.624
59	Lever..........25A	M,Ind	8-3⅛x6	87-1800	82-1800	368.0	5.90	250-1800	N	In	L	Sil	1.68	1.62	1.50	1.43	.352	.352	.375	.375
60	Mack..........EN-310	T,B	6-3⅝x5	97-2700	83-2700	310.0	5.6	214-1200	N	In	L	AUS	1.89	1.76	1.62	1.44	.365	.365	.373	.371
61	Mack..........EN-354	T,B,FA	6-3⅞x5	112-2700	98-2700	354.0	5.5	254-1000	N	In	L	AUS	1.89	1.76	1.62	1.44	.365	.365	.373	.371
62	Mack..........EN-431	T	6-4⅛x5⅜	124-2500	108-2500	431.0	5.72	325-1200	N	In	I	AUS	1.95	1.72	1.81	1.56	.418	.418	.435	.433
63	Mack..........EN-471	T	6-4 5/16x5⅜	133-2400	118-2400	471.0	5.63	352-1200	N	In	I	AUS	1.95	1.72	1.81	1.56	.418	.418	.435	.433
64	Mack..........EN-510	T,B,FA	6-4 7/16x5½	144-2400	129-2400	510.0	5.63	382-1200	N	In	I	AUS	1.95	1.72	1.81	1.56	.418	.418	.435	.433
65	Mack..........EN-611	T,B,FA	6-4¾x5¾	161-2100	147-2100	611.0	5.4	465-900	N	In	I	AUS	2.27	1.99	2.05	1.77	.512	.512	.498	.496
66	Mack..........EN-707	T,B,FA	6-5x6	176-2000	162-2000	707.0	5.35	530-600	N	In	I	AUS	2.27	1.99	2.05	1.77	.512	.512	.498	.495
67	M-M Twin City (8)..........EE	Tr, Ind	4-3⅝x4	26-1400	24-1400	165.1	5.75	107-1000 (BE)	N	Se	HH	......	1.46	1.46	1.25	1.25	.354	.354	.343	.343
68	M-M Twin City..........RE	Tr, Ind	4-3⅝x4½	34-1500	32-1500	185.7	5.75	124-1100 (BE)	N	Se	HH	......	1.46	1.46	1.25	1.25	.354	.354	.343	.343
69	M-M Twin City..........KEF	Tr, Ind	4-4¼x5	49-1275	47-1275	283.7	5.40	212-1000 (BE)	N	Se	I	......	1.71	1.59	1.50	1.37	.488	.488	.437	.437
70	M-M Twin City..........LE	Tr, Ind	4-4⅝x6	64.5-1075	61-1075	403.2	5.25	315-900 (BE)	N	Se	I	......	1.84	1.71	1.62	1.50	.488	.488	.437	.437
71	M-M Twin City..........ME	Ind	4-8x9	152-650	....	1810.0	4.70	1250-500 (BE)	N	Se	I	......	3.34	3.34	3.00	3.00	.687	.683	.687	.687
72	M-M Twin City..........CE	Ind	6-4¼x5	72-1275	....	425.5	5.40	302-1100 (BE)	N	Se	I	......	1.71	1.59	1.50	1.37	.488	.488	.437	.437
73	M-M Twin City..........HE	Ind	6-4⅝x6	92-1075	....	605.0	5.25	445-1000 (BE)	N	Se	I	......	1.84	1.71	1.62	1.50	.488	.488	.437	.433
74	M-M Twin City..........NE	Ind	6-8x9	220-650	....	2714.0	4.70	1880-450 (BE)	N	Se	I	......	3.34	3.34	3.00	3.00	.687	.683	.687	.683
75	M-M Twin City..........OEA	Tr, Ind	4-3⅝x5	40-1500	38-1500	206.5	6.15	150-1100 (BE)	N	Se	HH	......	1.46	1.46	1.25	1.25	.354	.354	.343	.343
76	Oliver..........60HC	Tr	4-3 5/16x3½	....	21.2-1500	120.6	6.00	75-1000 (EA)	W	In	I	Sil	1.18	1.12	1.06	1.00	.281	.281	.375	.375
77	Oliver..........80HC	Tr	4 4¼x5¼	....	46.1-1200	298.0	5.25	190-850 (EA)	W	In	I	Sil	2.00	1.75	1.75	1.50	.406	.406	.375	.375
78	Oliver..........80KD	Tr	4-4½x5¼	....	45-1200	334.0	4.23	190-850 (EA)	W	In	I	Sil	2.00	1.75	1.75	1.50	.406	.406	.375	.375
79	Oliver..........90	Tr	4-4¾x6¼	....	56.7-1125	443.0	4.10	250-850 (EA)	W	In	I	Sil	2.31	2.31	2.00	2.00	.437	.437	.437	.437
80	Oliver..........99	Tr	4-4¾x6¼	....	65-1125	443.0	5.04	295-850 (EA)	W	In	I	Sil	2.31	2.00	2.00	1.75	.437	.437	.437	.437
81	Oliver..........70KD	Tr	6-3⅛x4⅜	....	31.3-1500	201.3	4.50	105-1150 (EA)	W	In	I	Sil	1.54	1.20	1.37	1.06	.390	.390	.375	.375
82	Oliver..........70HC	Tr	6-3⅛x4⅜	....	36.3-1500	201.3	6.50	105-1150 (EA)	W	In	I	Sil	1.54	1.20	1.37	1.06	.390	.390	.375	.375
83	Reo..........GC-228	T	6-3⅜x4¼	83-3200	....	228.0	6.20	177-1000 (BE)	N	In	L	Sil	1.78	1.62	......	......	.324	.324	.373	.373
84	Reo..........GC-245	T	6-3½x4¼	89-3100	....	245.0	6.20	191-1000 (BE)	N	In	L	Sil	1.78	1.62	......	......	.324	.324	.373	.373

(For abbreviations see pages 138-139)

Engines—*Continued*

Valves: Seats: Angle (Deg.)	Inserts Used?	Insert Material (S.A.E. No.)	Camshaft Drive—Type	Pistons: Material	Weight with Pins, Rings, Bushings (Oz.)	Piston Pin—Diameter and Length (In.)	Number of Rings per Piston	Connecting Rods: Material	Center to Center Length (In.)	Weight with Bushing and Cap (Oz.)	Crankshaft: Material	Counter Balance Used	Crank-Pin: Diameter and Length (In.)	Main Bearings: Number	Diameter and Length (In.): Front	Rear	Oil Pressure to—	Spark Plug—Thread Size	Carburetor: Make	Size	Engine Weight without Carburetor or Ignition (Lb.)	Overall Dimensions (In.): Width	Height	Length	Line Number
30	E	......	HG	Al	117	1.50x4.81	4	3140	12	143	CS‡	Op	3.00x2.25	7	3.50x2.37	3.50x3.50	abce	7/8-18	Op	2	1830	24 1/2	40 1/2	54 1/2	1
30	E	......	HG	Al	127	1.50x5.06	4	3140	12	143	1045	Op	3.00x2.25	7	3.50x2.37	3.50x3.50	abce	7/8-18	Op	2	1830	24 1/2	40 1/2	54 1/2	2
45	N	......	SB	CI	35	.919x2.50	4	1040	7 1/4	33	1045	N	1.75x1.19	3	2.12x1.37	2.12x1.84	abceg	18 mm	Zen	7/8	457*	16 9/16	33 1/2	30 11/16	3
45	N	......	SB	CI	53	1.11x2.78	4	1040	8	57	1045	N	2.25x1.23	3	2.50x1.49	2.50x1.49	abceg	18 mm	Own	1	639*	17 1/2	32 11/32	33 1/8	4
45	E	MA	SB	CI	82	1.31x3.25	4	1040	10	.....	1045	N	2.50x1.72	3	2.75x1.56	2.75x1.56	abceg	18 mm	Own	1 1/4	914*	19 1/2	38 3/4	37	5
45	E	MA	SG	CI	111	1.50x3.71	4	1040	11	123	1045‡	Y	2.99x1.97	3	3.25x1.82	3.25x1.82	abcdeg	7/8-18	Own	1 3/8	1253*	23 13/16	42 5/16	40 1/4	6
45	E	MA	Ch	CI	38	.978x2.88	4	1040	8 1/4	34	1045	Y	2.00x1.31	4	2.62x1.54	2.62x2.09	abcde	18 mm	Zen	1 1/4	624*	23 3/4	29 5/16	38 7/16	7
45	E	MA	SB	Al	31	.919x2.95	4	3140	8 9/16	43	4140	Y	2.12x1.68	4	2.70x1.12	2.70x1.23	abcdeg	14 mm	Zen	1 1/4	874*	22 3/8	31 3/8	47 3/8	8
15	E	MA	SB	Al	50	1.11x3.80	4	3140	9	61	1045	Y	2.75x1.68	7	3.25x1.34	3.25x1.84	abcdeg	14 mm	Zen	1 3/4	1076*	27 1/8	37 13/16	47 5/16	9
30	N	......	HG	CI	19	.687x2.18	3	CS	5 1/8	15	CS	N	1.50x1.00	3	2.00x1.37	2.00x1.31	abcr	14 mm	Str	3/4	300*	18 11/16	17 5/8	29 5/16	10
30	N	......	HG	Al	20	.750x2.87	4	3140	6 9/16	20	CS	N	1.75x1.12	3	2.00x1.62	2.00x1.58	abcr	7/8-18	Str	1 1/4	405*	23 1/2	21 11/16	34 5/16	11
45	N	......	Ch	Al	12	.812x2.78	3	MS	9 3/16	34	1040	Y	1.93x1.31	3	2.33x1.75	2.33x1.92	abcr	14 mm	Str	1 1/4	495	21 1/4	24 1/2	36	12
45	N	......	Ch	Al	12	.812x2.78	3	MS	9 3/16	34	1040	Y	1.93x1.31	3	2.33x1.75	2.33x1.92	abcr	14 mm	Str	1 1/4	495	21 1/4	24 1/2	36	13
45	N	......	Ch	Al	12	.812x2.78	3	MS	9 3/16	34	1040	Y	1.93x1.31	3	2.33x1.75	2.33x1.92	abcr	14 mm	Str	1 1/4	495	21 1/4	24 1/2	36	14
(h)	N	......	Ch	CNI	32	.937x2.87	3	DFS	7 9/16	32	DFS	Y	2.00x1.06	5	2.50x1.87	2.37x1.25	abcder	14 mm	Str	1 1/2	860*	24	23 3/16	52 1/2	15
30	N	......	HG	Al	24	.875x2.79	4	CS	7	26	CS	N	2.00x1.25	7	2.50x1.93	2.50x1.87	abcr	7/8-18	Str	1 1/2	620*	24	24 1/8	42 5/16	16
(h)	N	......	Ch	CI	.....	....	3	DFS	7 9/16	37	DFS	Y	2.12x1.28	4	2.62x1.56	2.50x1.25	abcder	14 mm	Str	1 1/2	790*	24	23 3/16	47 7/8	17
30	N	......	HG	Al	40	1.00x3.51	4	CS	8	38	CS	N	2.00x1.50	7	2.50x2.12	2.50x1.37	abcr	7/8-18	Str	1 3/4	925*	21 13/16	27 3/4	52 3/8	18
45	N	......	HG	Al	.....	1.12x3.68	4	CS	9 1/8	51	CS	N	2.25x1.50	7	2.62x1.75	2.62x2.75	abcr	14 mm	Str	1 3/4	1125*	24 1/4	29 5/8	56 3/16	19
30	N	......	HG	Al	.....	1.12x3.62	4	CS	9	51	CS	Y	2.25x1.12	7	2.68x2.75	2.68x1.75	abcr	14 mm	Str	2	1125*	24 1/4	29 5/8	56 3/16	20
(h)	E	HS	HG	Als	62	1.25x3.62	4	DFS	11	80	CS	N	2.25x2.23	7	2.50x3.91	2.50x2.56	abcder	14 mm	Str	2	1390*	26 3/4	33 1/4	69 7/8	21
45	N	......	HG	Als	82	1.25x4.50	4	DFS	11	80	CS	N	2.25x2.23	7	2.50x3.91	2.50x2.62	abcder	18 mm	Str	2	1570*	29 13/16	34 1/16	69 7/8	22
45	N	......	HG	Als	82	1.25x4.50	4	DFS	11	80	CS	N	2.25x2.23	7	2.50x3.91	2.50x2.62	abcder	14 mm	Str(2)	1 3/4	1570*	26 1/8	34 1/16	69 7/8	23
45	N	......	SB	Als	82	1.25x4.50	4	DFS	11	80	DFS	N	2.25x2.23	7	2.50x3.91	2.50x2.62	abcder	18 mm	Str(2)	1 3/4	1500*	30 1/2	39 3/4	69 3/4	24
45	Bo	TA	HG	CAS	12	.750x2.85	3	AS	7	16	CAS	Y	2.00x1.94	3	2.00x1.81	2.00x2.25	abcr	7/8-18	Ford	....	730	29 1/16	31 7/16	43 13/16	25
45	Bo	TA	HG	CAS	17	.750x2.84	3	AS	7	17	CAS	Y	2.14x1.75	3	2.50x1.72	2.50x2.25	abce	14 mm	Ford	....	730	29 1/16	31 7/16	43 13/16	26
(h)	......	......	Ch	CI	32	.937x2.87	3	DFS	7 9/16	32	DFS	Y	2.00x1.56	5	2.37x2.25	2.24x1.31	abcder	14 mm	Str	1 1/2	860*	24	23 3/16	52 1/2	27
45	Bo	TA	HG	CAS	11	.750x2.48	3	DFS	.....	22	CAS	Y	2.12x1.57	4	2.40x1.83	2.40x2.54	abce	14 mm	Ford	....	800	24 11/16	32	51 1/2	28
45	N	......	SB	Als	82	1.25x4.50	4	CNS	11	184	CNS	Y	2.75x2.25	7	3.00x3.84	3.00x2.25	abcder	18 mm	Str(4)	2	2700*	42 1/2	43 9/16	75 13/16	29
45	......	......	HG	CI	160	1.37x4.62	4	AS	12 1/4	96	CNS	N	1.87x2.75	3	2.25x5.00	2.25x4.00	abe	7/8-18	Zen	1 1/4	975	23 1/2	22	55 1/2	30
45	......	......	HG	CI	179	1.37x5.00	4	AS	12 1/4	96	CNS	N	1.87x2.75	3	2.25x5.00	2.25x4.00	abe	7/8-18	Zen	1 1/4	1000	23 1/2	22	55 1/2	31
45	......	......	HG	CI	160	1.37x4.62	4	AS	12 1/4	96	CNS	N	1.87x2.75	4	2.25x5.00	2.25x4.00	abe	7/8-18	Zen	1 1/2	1400	25	22 1/4	60 1/2	32
45	......	......	HG	CI	179	1.37x5.00	4	AS	12 1/4	96	CNS	N	1.87x2.75	4	2.25x5.00	2.25x4.00	abe	7/8-18	Zen	1 1/2	1450	25	22 1/4	60 1/2	33
30	......	......	HG	Al	.....	.750x2.81	3	AS	6 9/16	.....	CNS	N	1.87x2.75	4	....	....	abe	7/8-18	Zen	1	440	17 1/2	14 3/8	40 1/2	34
45	......	......	HG	CI	160	1.37x4.62	4	AS	12 1/4	96	CNS	N	2.00x1.50	3	2.00x2.18	2.00x2.62	abe	7/8-18	Zen	1 1/2	1700	25 3/4	22 1/4	68 1/2	35
45	......	......	HG	CI	179	1.37x5.00	4	AS	12 1/4	96	CNS	N	1.87x2.75	5	2.25x5.00	2.25x4.00	abe	7/8-18	Zen	1 1/2	1750	25 3/4	22 1/4	68 1/2	36
45	E	Spec	HG	CI	186	1.50x5.00	4	AS	13 1/4	172	CNS	N	1.87x2.75	5	2.25x5.00	2.25x4.00	....	7/8-18	Zen	....	2100	29 1/4	24	74 1/4	37
45	E	Spec	HG	CI	204	1.50x5.50	4	AS	13 1/4	172	CNS	N	2.75x2.75	5	3.00x3.50	3.00x3.50	abce	7/8-18	Zen	....	2290	29 1/4	24	75	38
30	......	......	HG	Al	.....	1.00x3.50	3	AS	8	.....	CNS	N	2.75x2.75	5	3.00x3.50	3.00x3.50	abce	7/8-18	Zen	1 1/4	830	21 1/8	17	51	39
30	E	Spec	HG	Al	40	1.00x3.50	4	DFS	8	36	Spec	N	2.00x1.50	7	2.50x1.31	2.50x2.12	abe	7/8-18	Zen	1 1/2	820	21 1/8	25	51	40
45	......	......	HG	CI	96	1.37x3.87	4	Dur	12 1/4	68	CNS	N	2.00x1.50	7	2.50x1.31	2.50x1.12	abe	7/8-18	Hol	....	1700	24 1/2	27 3/4	68	41
45	......	......	HG	CI	104	1.37x4.12	4	Dur	12 1/4	68	CNS	N	2.25x2.37	7	2.75x3.25	2.75x2.12	abce	7/8-18	Hol	....	1700	24 1/2	27 3/4	68	42
45	......	......	HG	CI	179	1.37x5.00	4	AS	12 1/4	96	CNS	N	2.25x2.37	7	2.75x3.25	2.75x2.12	abce	7/8-18	Zen(2)	1 1/2	2500	26 1/2	22 3/4	90 1/2	43
45	......	......	HG	CI	179	1.37x5.00	4	AS	12 1/4	96	CNS	N	2.12x2.75	7	2.62x5.00	2.62x4.00	abe	7/8-18	Zen(2)	1 1/2	2500	26 1/2	29 3/4	88 1/2	44
45	......	......	HG	CI	176	1.50x5.00	4	AS	13 1/4	164	CNS	N	2.12x2.75	7	2.62x5.00	2.62x4.00	abe	7/8-18	Hol	...	2435	24 1/2	29 3/8	78 1/2	45
45	......	......	HG	CI	176	1.50x5.12	4	AS	13 1/4	164	CNS	N	2.75x2.75	7	3.00x3.37	3.00x3.25	abce	7/8-18	Hol	....	2460	24 1/2	29 3/8	78 1/2	46
45	N	......	HG	CI	22	.750x....	3	1045	8 1/2	22	1040	N	1.93x1.37	2	310(9)	310(9)	PS	18 mm	Zen	7/8	400	18	19 3/16	24	47
45	E	......	HG	CI	46	1.00x3.18	3	1040	7 1/2	33	1045	Y	2.31x1.06	3	2.50x1.43	2.50x1.43	abc	18 mm	Zen	7/8	575	16 3/4	31 1/2	33	48
45	E	......	HG	CI	54	.989x3.31	4	1045	7 1/2	60	1045	N	2.37x1.53	3	2.43x1.62	2.46x1.75	abc	14 mm	Zen	1 1/8	650	20	30	35 1/2	49
45	E	......	HG	CI	70	.989x3.50	4	1045	8	60	1045	N	2.37x1.53	3	2.43x1.62	2.46x1.75	abce	14 mm	Zen	1 1/8	650	20	31	35 1/2	50
45	E	......	HG	CI	70	.989x3.50	4	1045	7 1/2	60	1045	N	2.37x1.53	3	2.43x1.62	2.46x1.75	abce	14 mm	Zen	1 1/8	650	20	30	35 1/2	51
45	E	......	HG	CI	107	1.50x3.93	4	1040	12 1/2	102	1045	N	2.50x2.75	3	2.62x3.50	2.62x3.75	abce	18 mm	Zen	1 1/4	1600	23	43 1/2	45 1/2	52
45	E	......	HG	CI	107	1.50x3.93	4	1040	12 1/2	102	1045	N	2.87x2.37	3	3.00x3.12	3.00x4.12	abce	18 mm	Zen	1 1/4	1550	23	43 1/2	45 1/2	53
45	E	......	HG	CI	128	1.50x4.37	3	1040	12 1/2	102	1045	N	2.87x2.37	3	3.00x3.12	3.00x4.12	abce	18 mm	Zen	1 1/4	1600	23	43 1/2	45 1/2	54
45	E	......	HG	CI	283	1.75x6.25	4	1045	14	236	1045	N	3.50x3.75	3	3.93x5.25	3.93x5.25	abce	18 mm	Zen	1 3/4	3100	34	59	62	55
45	E	......	HG	CI	283	1.75x....	4	1045	14	236	4140	N	3.50x3.75	4	3.93x5.25	3.93x5.25	abce	18 mm	Zen(2)	1 1/2	4500	34	59	80	56
45	E	......	HG	CI	255	1.75x6.12	4	3140	14	295	1045	Y	3.50x3.75	3	3.93x5.25	3.46x5.25	abce	18 mm	Zen(2)	2	4500	45	65	64	57
45	E	......	HG	CI	255	1.75x6.37	4	3140	14	295	4140	Y	3.50x3.75	4	3.93x5.25	3.93x5.25	abce	18 mm	Zen	1 3/4	6000	45	65	78	58
45	E	CA	Ch	Al	18	.812x1.56	4	....	....	.....	1045	N	2.75x1.37	5	3.00x1.50	3.00x2.37	abce	14 mm	Zen	1 1/2	1150	23 1/2	35	49 3/4	59
30	E	NIS	HG	Al	39	1.00x3.25	5	AS	11 1/4	65	CSC	Y	2.38x1.34	7	3.00x1.56	3.00x2.56	abc	18 mm	Zen	1 1/2	900	18	30	38	60
30	E	NIS	HG	Al	42	1.00x3.50	5	AS	11 1/4	65	CSC	Y	2.38x1.34	7	3.00x1.56	3.00x2.56	abcf	18 mm	Zen	1 3/4	910	18	30	38	61
30	E	NIS	HG	Al	66	1.31x3.69	5	AS	10 1/2	75	CSC	Y	2.75x1.72	7	3.50x1.68	3.50x2.28	abcfg	18 mm	Zen	1 3/4	1400	21	38	49	62
30	E	NIS	HG	Al	68	1.31x3.87	5	AS	10 1/2	75	CSC	Y	2.75x1.72	7	3.50x1.68	3.50x2.28	abcfg	18 mm	Zen	1 3/4	1415	21	38	49	63
30	E	NIS	HG	Al	71	1.31x4.00	5	AS	10 1/2	75	CSC	Y	2.75x1.72	7	3.50x1.68	3.50x2.28	abcfg	18 mm	Zen	1 3/4	1430	21	38	49	64
30	E	NIS	HG	Al	83	1.44x4.16	5	AS	11 1/4	106	CSC	Y	3.00x2.38	7	3.50x1.68	3.50x2.38	abcfg	18 mm	Zen	2	1757	23	35	53	65
30	E	NIS	HG	Al	91	1.44x4.41	5	AS	11 1/4	106	CSC	Y	3.00x2.38	7	3.50x1.68	3.50x2.38	abcfg	18 mm	Zen	2	1825	23	35	53	66
45	E	CNM	HG	CI	55	1.00x3.00	4	1040	9	51	1045	N	2.62x1.28	2	SAE212(9)	3.00x2.18	abet	14 mm	Sch	1	600	25 3/4	32 9/16	37 9/16	67
45	E	CNM	HG	CI	54	1.00x3.00	4	1040	9	51	1045	N	2.62x1.28	2	BCA313(9)	BCA314(9)	bet	14 mm	Sch	1	600	25 3/4	32 9/16	37 9/16	68
45	E	CNM	HG	CI	80	1.25x3.87	4	1040	10	90	1045	N	2.57x2.21	3	2.90x2.18	2.90x3.50	abcegt	7/8-18	Sch	1 1/4	1140	29 1/4	41 1/2	41 1/2	69
45	E	CNM	HG	CI	104	1.25x4.25	4	1040	11 1/4	100	1045	N	2.75x2.09	3	2.90x2.18	2.90x3.17	abcegt	7/8-18	Sch	1 1/4	1275	24 1/2	60	45 1/2	70
45	Bo	CNM	HG	CI	598	2.18x7.18	4	1045	20 1/2	656	1045	N	3.50x4.37	5	3.50x5.21	3.50x6.37	abcdegt	7/8-18	Zen	2	4700	38 1/2	68 1/4	72	71
45	E	CNM	HG	CI	80	1.25x3.87	4	1040	10	90	1045	Y	2.57x2.21	4	2.90x2.18	2.90x3.50	abcegt	7/8-18	Zen	1 1/2	1850	28 3/4	45 5/16	59 1/4	72
45	E	CNM	HG	CI	104	1.25x4.25	4	1045	11 1/4	100	1045	Y	2.75x2.09	4	2.90x2.18	2.90x3.50	abcegt	7/8-18	Zen	1 1/2	1950	28 3/4	48 5/16	59 1/4	73
45	Bo	CNM	HG	CI	598	2.18x7.18	4	1045	20 1/2	608	1045	N	3.81x4.25	7	4.00x5.21	4.00x6.37	abcdegt	7/8-18	Zen(2)	1 3/4	6650	37 1/2	74	97	74
45	E	CNM	HG	CI	54	1.00x3.00	4	1040	8 3/4	45	1045	N	2.62x1.28	3	SAE212(9)	3.00x2.18	abe	14 mm	Sch	1	700	25 3/4	32 9/16	37 9/16	75
45	E	CA	HG	CI	45	.875x2.70	4	1045	8	29	1045	N	2.00x1.37	3	2.25x1.43	2.25x1.43	a	18 mm	Sch	1	345	17	24 1/2	28 1/2	76
45	E	CA	HG	CI	83	1.31x3.81	4	1045	10 1/2	68	1045	N	2.37x2.12	3	2.37x2.12	2.37x2.75	abcde	7/8-18	Sch	1 1/4	850	21 1/4	34 3/4	37 3/4	77
45	E	CA	HG	CI	94	1.31x4.06	4	1045	10 1/2	68	1045	N	2.37x2.12	3	2.37x2.12	2.37x2.75	abcde	7/8-18	Sch	1 1/4	850	21 1/4	24 3/4	37 3/4	78
45	E	CA	HG	CI	109	1.50x4.37	4	1040	12 1/2	145	1045	N	2.75x2.50	3	3.00x2.81	3.00x3.75	abcde	7/8-18	Sch	1 1/4	1200	24 1/4	44	44 1/4	79
45	E	CA	HG	CI	109	1.50x4.37	4	1040	12 1/2	145	1045	N	2.75x2.50	3	3.00x2.81	3.00x3.75	abcde	7/8-18	Sch	1 1/4	1200	24 1/4	44	44 1/4	80
(h)	E	CA	HG	CI	39	.859x2.62	4	1030	7	28	1045	N	1.93x1.12	4	2.25x1.23	2.25x1.62	ab	18 mm	Zen	1 1/4	550	17 1/2	29	31 1/2	81
(h)	E	CA	HG	CI	39	.859x2.62	4	1030	7	28	1045	N	1.93x1.12	4	2.25x1.23	2.25x1.62	ab	18 mm	Zen	1	530	17 1/2	29	31 1/2	82
45	E	......	Ch	Al	23	.983x2.90	4	1035	10 1/2	50	1045	Y	2.19x1.50	7	2.62x1.94	2.62x2.47	abcde	14 mm	Zen	1 1/4	758*	19 1/4	30 1/4	38 3/4	83
45	E	......	Ch	Al	26	.983x3.03	4	1035	10 1/2	50	1045	Y	2.19x1.50	7	2.62x1.94	2.62x2.47	abcde	14 mm	Zen	1 1/4	763*	19 1/4	30 1/4	38 3/4	84

(For abbreviations see pages 138-139)

American Gasoline

Line Number	ENGINE MAKE AND MODEL	Designed for	Number of Cylinders, Bore and Stroke (In.)	MAXIMUM BRAKE Hp. at Specified R.P.M.: With Bare Engine	MAXIMUM BRAKE Hp. at Specified R.P.M.: With Standard Accessories	Piston Displacement (Cu. In.)	Compression Ratio	Maximum Torque at R.P.M. (Lb. Ft., with or without Accessories	Cylinder Liners—Type	Crankcase—Upper Half Integral with Cylinders	VALVES: Arrangement	VALVES: Exhaust Head Material (S.A.E. No.)	Max. Head Diameter (In.): Intake	Max. Head Diameter (In.): Exhaust	Min. Port Diameter (In.): Intake	Min. Port Diameter (In.): Exhaust	Lift (In.): Intake	Lift (In.): Exhaust	Stem Diameter (In.): Intake	Stem Diameter (In.): Exhaust
1	Reo....GC-288	T	6-3½x5	94-3000	....	288.0	6.20	221-1200 (BE)	N	In	L	SII	1.78	1.62	....	....	.324	.324	.373	.373
2	Reo....GC-310	T, B	6-3⅝x5	101-3000	....	310.0	6.20	241- 900 (BE)	N	In	L	SII	1.78	1.62	....	....	.324	.324	.373	.373
3	Scripps....34	M	4-3¼x4	....	32-2200	134.0	5.20	92-2000 (BE)	....	In	L	SII	1.48	1.35	1.25	1.12	.250	.250	.310	.310
4	Scripps....36	M	4-3¼x4	....	50-3200	134.0	....	....	....	In	L	SII	1.48	1.35	1.25	1.12	.250	.250	.310	.310
5	Scripps....F4	M	4-3¾x5	....	81-3000	220.0	6.10	....	....	In	L	SII	1.93	1.93	....	....	.406	.406	.375	.375
6	Scripps....96A-97A	M	6-3 7/16x4⅛	....	95-3000	221.0	5.85	187-1200 (BE)	....	In	L	SII	1.60	1.39	1.43	1.12	.281	.281	.312	.312
7	Scripps....F6	M	6-3¾x5	....	120-3000	331.0	6.10	....	....	In	L	SII	1.93	1.93	....	....	.406	.406	.375	.375
8	Scripps....104A-105A	M	6-4x4¼	....	110-3000	320.0	5.63	239-1700 (BE)	....	In	L	SII	1.75	1.62	1.50	1.37	.322	.322	.373	.373
9	Scripps....152-153	M	6-4¼x5¼	....	169-3000	447.0	6.20	....	....	Se	L	SII	2.25	2.25	....	....	.375	.375	.437	.437
10	Scripps....154, 5, 6, 7	M	6-4¼x5¼	....	155-3000	447.0	6.20	....	....	Se	L	SII	2.25	2.25	....	....	.375	.375	.437	.437
11	Scripps....162-163	M	6-4½x5¾	....	166-2400	549.0	5.75	....	....	Se	L	SII	2.37	2.28	....	....	.405	.375	.437	.437
12	Scripps....166-167	M	6-4½x5¾	....	145-2200	549.0	5.20	....	....	Se	L	SII	2.56	2.28	....	....	.405	.375	.437	.437
13	Scripps....168-169	M	6-4½x5¾	....	175-2400	549.0	5.75	....	....	Se	L	SII	2.37	2.28	....	....	.405	.375	.437	.437
14	Scripps....172A-173A	M	6-4¾x5¾	....	200-2400	611.0	5.20	....	....	Se	L	SII	2.37	2.28	....	....	.405	.375	.437	.437
15	Scripps....176A-177A	M	6-4¾x5¾	....	155-2200	611.0	5.20	....	....	Se	L	SII	2.56	2.28	....	....	.405	.375	.437	.437
16	Scripps....178-179	M	6-4¾x5¾	....	200-2400	611.0	5.75	....	....	Se	L	SII	2.37	2.28	....	....	.405	.375	.437	.437
17	Scripps....202-203	M	6-5x5¾	....	212-2400	678.0	6.20	....	....	Se	L	SII	2.56	2.28	....	....	.405	.375	.437	.437
18	Scripps....206-207	M	6-5x5¾	....	170-2200	678.0	5.75	....	....	Se	L	SII	2.56	2.28	....	....	.405	.375	.437	.437
19	Scripps....208-209	M	6-5x5¾	....	225-2400	678.0	5.85	....	....	Se	L	SII	2.50	2.37	....	....	.406	.375	.437	.437
20	Scripps....214-215	M	6-5x5¾	....	185-2000	678.0	5.75	....	....	Se	L	SII	2.50	2.37	....	....	.406	.375	.437	.437
21	Scripps....V43-90, V47-90	M	8-3 1/16x3¾	....	90-3600	221.0	6.16	154-2200 (BE)	....	In	L	SII	1.53	1.53	....	....	.296	.296	.312	.312
22	Scripps...V43M-100, V47M-100	M	8-3.185x3¾	....	100-3600	239.0	6.15	178-2200 (BE)	....	In	L	CNS	1.53	1.53	....	....	.292	.292	.311	.311
23	Scripps....V63-130, V67-130	M	12-2 15/16x3¾	....	130-3600	305.0	6.70	232-2200 (BE)	....	In	L	CNS	1.53	1.53	....	....	.292	.292	.311	.311
24	Scripps....302-303	M	12-4¼x5¼	....	304-2400	894.0	6.20	....	....	Se	L	SII	2.25	2.25	....	....	.375	.375	.437	.437
25	Scripps....304-305	M	12-4¼x5¼	....	250-2400	894.0	6.20	....	....	Se	L	SII	2.25	2.25	....	....	.375	.375	.437	.437
26	Scripps....306-307	M	12-4¼x5¼	....	280-2400	894.0	6.20	....	....	Se	L	SII	2.25	2.25	....	....	.375	.375	.437	.437
27	Sterling....Petrel L-6	M,T,Tr,B,Ind	6-5¼x6	....	115-1200	780.0	4.30	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
28	Sterling....Petrel L-6	M,T,Tr,B,Ind	6-5¼x6	....	145-1500	780.0	4.68	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
29	Sterling....Petrel L-6	M,T,Tr,B,Ind	6-5¼x6	....	145-1500	780.0	4.68	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
30	Sterling....Petrel L-6-6	M,T,Tr,B,Ind	6-5¼x6	....	180-1800	780.0	5.00	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
31	Sterling....Petrel Reduction-L	M,T,Tr,B,Ind	6-5¼x6	....	175-1800	780.0	4.68	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
32	Sterling....Petrel L-6	M,T,Tr,B,Ind	6-5¼x6	....	200-2000	780.0	5.54	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
33	Sterling....Petrel L-6	M,T,Tr,B,Ind	6-5¼x6	....	225-2200	780.0	5.50	500-1400 (EA)	N	Se	L	SII	2.25	2.25	....	....	.455	.455	.437	.437
34	Sterling..Dolphin-Med. GRM-6	Tr, M, Ind	6-5¾x6¾	....	165-1200	1051.6	3.85	785-1200 (EA)	N	Se	I	SII	1.87	1.87	....	....	.375	.375	.437	.437
35	Sterling....Dolphin 6-GR-6	Tr, M, Ind	6-5¾x6¾	....	225-1550	1051.6	4.08	785-1200 (EA)	N	Se	I	SII	1.87	1.87	....	....	.375	.375	.437	.437
36	Sterling....Dolphin 6-GRS-6	Tr, M, Ind	6-5¾x6¾	....	300-2000	1051.6	4.70	785-1200 (EA)	N	Se	I	SII	1.87	1.87	....	....	.375	.375	.437	.437
37	Sterling....Viking 11 T-6	Tr, M, Ind	6-8x9	....	190- 600	2714.3	3.93	1900-1000 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.562	.562
38	Sterling....Viking 11 T-6	Tr, M, Ind	6-8x9	....	300- 900	2714.3	4.18	1900-1000 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.562	.562
39	Sterling....Viking 11 T-6	Tr, M, Ind	6-8x9	....	425-1200	2714.3	4.18	1900-1000 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.562	.562
40	Sterling....Viking 11 8-T-8	Tr, M, Ind	8-8x9	....	250- 600	3619.0	3.93	2520-1050 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.557	.557
41	Sterling....Viking 11 8-T-8	Tr, M, Ind	8-8x9	....	400- 900	3619.0	4.18	2520-1050 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.557	.557
42	Sterling....Viking 11 8-T-8	Tr, M, Ind	8-8x9	....	565-1200	3619.0	4.18	2520-1050 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.557	.557
43	Sterling....Viking 11TC68	M	8-8x9	....	600-1200	3619.0	5.00	2626-1200 (EA)	W	Se	I	SII	2.59	2.59	....	....	.556	.556	.557	.557
44	Sterling....Admiral ‡V-2500-6	M	12-6⅜x6½	....	1200-2350	2500.0	6.00	.... (EA)	W	Se	I	CNS x	2.18	2.21	2.00	2.00	.437	.497	.403	.559
45	Sterling....R. Admiral V-2500-7	M	12-6⅜x6 ½	....	800-2200	2500.0	6.00	.... (EA)	W	Se	I	CNS x	2.18	2.21	2.00	2.00	.437	.497	.403	.559
46	Thorobred (10)....KK	M	2-3¾x4¾	11-1100	10-1100	105.0	4.00	54-800 (EA)	N	Se	L	NCI	1.62	1.62	1.43	1.43	.300	.300	.375	.375
47	Thorobred....DS	M	4-2¾x4	19-1800	16-1800	95.0	4.66	53-1300 (EA)	N	In	L	SII	1.46	1.34	1.31	1.18	.250	.250	.312	.312
48	Thorobred....Arrowhead, Jr.	M	4-3¼x4	38-2600	35-2600	133.0	5.58	92-1200 (EA)	N	In	L	SII	1.34	1.34	1.18	1.18	.281	.281	.312	.312
49	Thorobred....Arrowhead	M	4-3⅝x4½	40-2200	37-2200	186.0	5.50	128-900 (EA)	N	In	L	SII	1.56	1.56	1.37	1.37	.281	.281	.375	.375
50	Thorobred....AA	M	4-3¾x4¾	27-1400	24-1400	210.0	4.00	113-700 (EA)	N	Se	L	NCI	1.62	1.62	1.43	1.43	.300	.300	.375	.375
51	Thorobred....F	M	4-4 1/16x5	39-1400	36-1400	259.0	4.00	142-1000 (EA)	N	Se	L	NCI	1.93	1.93	1.75	1.75	.300	.300	.375	.375
52	Thorobred....B	M	4-4½x5	47-1800	44 1800	318.0	4 00	180-900 (EA)	N	Se	L	CNS	2.09	2.09	1.93	1.93	.300	.300	.375	.375
53	Thorobred....BB-4	M	4-4½x6	59-1600	56-1600	382.0	4.00	224-1100 (EA)	N	Se	L	SII	2.34	2.34	2.12	2.12	.300	.300	.437	.437
54	Thorobred....BC-4	M	4-5x7	60-1200	56-1200	550.0	4.00	292-900 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2.37	.375	.375	.625	.625
55	Thorobred....BCS-4	M	4-5¾x7	75-1100	71-1100	727.0	4.00	409-900 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2.37	.375	.375	.625	.625
56	Thorobred....BC-Super-4	M	4-6x7	82-1100	78-1100	791.7	4.00	465-700 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2.37	.375	.375	.625	.625
57	Thorobred....Hiawatha	M	6-3¾x4¼	85-2800	82-2800	282.0	5.70	185-1100 (EA)	N	In	L	SII	1.68	1.43	1.50	1.25	.375	.375	.375	.375
58	Thorobred....Arrow-Super-6	M	6-4¼x4¾	98-2500	95-2500	404.0	5.38	286-800 (EA)	N	In	L	SII	1.93	1.43	1.75	1.25	.375	.375	.375	.375
59	Thorobred....BB-6	M	6-4½x6	84-1725	80-1725	572.5	4.00	379-900 (EA)	N	Se	L	SII	2.34	2.34	2.12	2.12	.300	.300	.437	.437
60	Thorobred....BBS-6	M	6-5x6	105-1500	101-1500	707.0	4.00	420-900 (EA)	N	Se	L	SII	2.34	2.34	2.12	2.12	.300	.300	.437	.437
61	Thorobred....BC-6	M	6-5x7	94-1100	90-1100	825.0	4.00	452-1000 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2 37	.375	.375	.625	.625
62	Thorobred....BCS-6	M	6-5¾x7	116-1100	112-1100	1091.0	4.00	596-850 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2.37	.375	.375	.625	.625
63	Thorobred....BC-Super-6	M	6-6x7	128-1100	124-1100	1187.5	4.00	630-875 (EA)	N	Se	L	Dia	2.75	2.75	2.37	2.37	.375	.375	.625	.625
64	Universal....Fisherman-WM	M	1-4⅜x4½	....	8-1200	67.6	4.60	....	N	In	L	CNS	1.87	1.87	....	....	.250	.250	.375	.375
65	Universal....Blue Jacket-AFTL	M	2-3x3½	....	12-2200	49.5	5.75	....	N	In	L	CNS	1.50	1.50	....	....	.250	.250	.375	.375
66	Universal....Utility Four-BN	M	4-2¾x4	....	25-2500	95.0	5.00	....	N	In	L	CNS	1.12	1.12	....	....	.234	.234	.312	.312
67	Universal....Flexifour-FA	M	4-3x3½	....	40-3500	99.0	5.00	....	N	In	L	SII	1.50	1.50	....	....	.312	.312	.375	.375
68	Universal....Superfour-LSG	M	4-3¼x4½	....	50-3000	149.3	5.70	....	N	Se	L	CNS	1.37	1.37	....	....	.312	.312	.375	.375
69	Universal....American Six-AMS	M	6-3x3½	....	60-3500	148.5	6.00	....	N	In	L	SII	1.50	1.50	....	....	.312	.312	.375	.375
70	Universal....Cruiser Six-HCS	M	6-3½x4½	....	90-3000	260.0	5.75	....	N	Se	L	SII	1.50	1.50	....	....	.312	.312	.375	.375
71	Universal....Sea Lion Six-LHS	M	6-3½x4½	....	110-3400	260.0	5.75	....	N	Se	L	SII	1.50	1.50	....	....	.312	.312	.375	.375
72	Universal....Cruiser Eight-GCE	M	8-3½x4½	....	125-3000	347.0	5.75	....	N	Se	L	SII	1.50	1.50	....	....	.328	.328	.375	.375
73	Universal....Sea Lion Eight-LCE	M	8-3½x4½	....	141-3400	347.0	5.75	....	N	Se	L	SII	1.50	1.50	....	....	.328	.328	.375	.375
74	Waukesha....(12) (H) 150	C, Ind	2-3x2¾	....	11-3200	39.0	5.60	19-2400 (EA)	N	In	L	SII	1.37	1.12	1.25	1.00	.300	.300	.312	.312
75	Waukesha....(12) ICK	M, Ind	4-2½x3⅛	18-2600	14-2000	61.3	5.70	40-1700 (BE)	N	Se	L	SII	1.12	.937	1.00	.812	.228	.250	.312	.312
76	Waukesha....(12) FCS	Tr, Ind	4-2¾x4	28-2600	17-1800	94.0	4.85	68-1000 (BE)	N	In	L	SII	1.34	1.34	1.18	1.18	.281	.281	.312	.312
77	Waukesha....(12) FC	T, Tr, Ind	4-3¼x4	35-2600	25-1800	133.0	5.58	86-1200 (BE)	N	In	L	SII	1.34	1.34	1.18	1.18	.281	.281	.312	.312
78	Waukesha....(12) 160	Ind	4-3 5/16x3½	27-1800	....	120.5	6.00	85-1200 (BE)	W	In	I	SII	1.18	1.12	1.06	1.00	.281	.281	.375	.375
79	Waukesha....(12) XAH	T, Ind	4-3⅝x4½	42-2200	33-1800	186.0	5.50	128-900 (BE)	N	In	L	SII	1.56	1.56	1.37	1.37	.302	.275	.375	.375
80	Waukesha....(12) 130GS	T, Tr, Ind	4-3¾x5	50-2200	36-1500	221.0	6.12	144-800 (BE)	W	In	I	SII	1.84	1.40	1.62	1.25	.445	.453	.434	.434
81	Waukesha....(12) 130GL	T, Tr, Ind	4-4x5	56-2200	41-1500	251.0	5.95	164-800 (BE)	W	In	I	SII	1.84	1.40	1.62	1.25	.445	.453	.434	.434
82	Waukesha....(12) VIM	Tr, Ind	4-4¼x5¼	52-1600	45-1400	298.0	4.23	200-1000 (BE)	W	In	I	SII	2.00	1.75	1.75	1.50	.400	.400	.375	.375
83	Waukesha....(12) VIK	Tr, Ind	4-4½x5¼	58-1600	50-1400	334.0	4.30	224-900 (BE)	W	In	I	SII	2.00	2.00	1.75	1.75	.400	.400	.375	.375
84	Waukesha....(12) VRZG	T, Tr, Ind	4-4⅝x5¼	64-1600	56-1400	353.0	6.10	241-1100 (BE)	W	In	I	SII	2.00	1.75	1.75	1.50	.450	.400	.375	.375
85	Waukesha....(11) 6BL	T, B, Ind	6-3½x4¼	72-2800	51-2000	245.0	5.70	165-1300 (BE)	N	In	L	SII	1.68	1.43	1.50	1.25	.375	.375	.375	.375
86	Waukesha....(11) 6BM	T, B, Ind	6-3⅝x4¼	77-2800	54-2000	263.0	5.70	178-1100 (BE)	N	In	L	SII	1.68	1.43	1.50	1.25	.375	.375	.375	.375
87	Waukesha....(11) 6BK	T, B, Ind	6-3¾x4¼	82-2800	59-2000	282.0	5.70	189-1100 (BE)	N	In	L	SII	1.68	1.43	1.50	1.25	.375	.375	.375	.375
88	Waukesha....(11) 6BZ	T, B, Ind	6-4x4¼	88-2800	65-2000	320.0	5.75	210-1000 (BE)	N	In	L	SII	1.68	1.43	1.50	1.25	.375	.375	.375	.375
89	Waukesha....(11) 6MKR	T, B, Ind	6-4⅛x4¾	98-2500	58-1600	381.0	5.34	270-800 (BE)	N	In	L	SII	1.93	1.43	1.75	1.25	.375	.375	.375	.375
90	Waukesha....(11) 6MZR	T, B, Ind	6-4¼x4¾	106-2500	66-1600	404.0	5.38	286-800 (BE)	N	In	L	SII	1.93	1.43	1.75	1.25	.375	.375	.375	.375
91	Waukesha....(11) 140-GS	T, B, Ind	6-4¼x5½	122-2250	114-2250	468.0	5.80	362-1000 (BE)	W	In	I	SII	2.12	1.56	1.87	1.37	.531	.469	.434	.434

(For abbreviations see pages 138-139)

Engines—*Continued*

Valves: Seats: Angle (Deg.)	Valves: Seats: Inserts Used?	Valves: Seats: Insert Material (S.A.E. No.)	Camshaft Drive—Type	Pistons: Material	Pistons: Weight with Pins, Rings, Bushings (Oz.)	Pistons: Piston Pin—Diameter and Length (In.)	Number of Rings per Piston	Connecting Rods: Material	Connecting Rods: Center to Center Length (In.)	Connecting Rods: Weight with Bushing and Cap (Oz.)	Crankshaft: Material	Crankshaft: Counter Balance Used	Crankshaft: Crank-Pin: Diameter and Length (In.)	Crankshaft: Main Bearings: Number	Crankshaft: Main Bearings: Diameter and Length (In.): Front	Crankshaft: Main Bearings: Diameter and Length (In.): Rear	Oil Pressure to—	Spark Plug—Thread Size	Carburetor: Make	Carburetor: Size	Engine Weight without Carburetor or Ignition (Lb.)	Overall Dimensions (In.): Width	Overall Dimensions (In.): Height	Overall Dimensions (In.): Length	Line Number
45	E	......	Ch	Al	26	.983x3.03	4	1035	10½	50	1045	Y	2.19x1.50	7	2.62x1.94	2.62x2.47	abcde	14 mm	Zen	1½	780*	19¼	30⅝	36¾	1
45	E	......	Ch	Al	29	.983x3.13	4	1035	10½	50	1045	Y	2.19x1.50	7	2.62x1.94	2.62x2.47	abcde	14 mm	Zen	1½	785*	19¼	30⅝	36¾	2
30	......	......	HG	CI	29	.750x2.81	3	3140	6 5/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abr	⅞-18	Zen	1¼	410*	15½	21¾	32⅝	3
30	......	......	HG	Al	......	.750x2.81	3	AS	6 5/16	21	1045	N	1.75x1.12	3	2.00x1.56	2.00x1.62	abr	⅞-18	Zen	1¼	410*	15½	21¾	32⅝	4
45	......	......	HG	Al	33	1.12x3.25	4	Dur	10½	41	NS	N	2.18x1.87	3	2.25x2.62	2.25x2.62	abc	18 mm	Str	1¼	860*	23	28 5/16	45¼	5
30	......	......	HG	Al	......	.875x2.90	4	CS	7	26	CS‡	N	2.00x1.25		2.50x1.31	2.50x1.93	abr	14 mm	Zen	1½	675*	21	23¼	41⅛	6
45	......	......	HG	Al	33	1.12x3.25	4	Dur	10½	41	NS	Y	2.18x1.87	4	2.25x2.62	2.25x2.62	abc	18 mm	Zen	1½	900*	19¾	28 11/16	56½	7
45	......	......	HG	Al	40	1.00x3.51	4	1035	8	37	1045	N	2.00x1.50	7	2.50x1.31	2.50x2.12	abr	⅞-18	Zen	1¾	880*	21	26½	49¾	8
45	E	Tun	HG	Al	49	1.25x3.68	4	AS	10⅞	70	NS	Y	2.75x2.25	4	3.25x2.25	3.25x2.25	abc	18 mm	Hol	2	1050*	27¾	32 5/16	56¾	9
45	E	Tun	HG	Al	49	1.25x3.68	4	AS	10⅞	70	NS	Y	2.75x2.25	4	3.25x2.25	3.25x2.25	abc	18 mm	Str	2	1150*	24¾	29⅞	56¾	10
45	......	......	HG	Al	50	1.37x3.84	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Hol	1½	1325*	26¼	36 5/16	66	11
45	......	......	HG	Al	50	1.37x3.84	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Sch	1½	1420*	33½	33 7/16	66	12
45	......	......	HG	Al	50	1.37x3.84	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Zen	2	1325*	33½	33 7/16	66	13
45	......	......	HG	Al	56	1.37x4.00	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Hol	2	1325*	26¼	37 5/16	66	14
45	......	......	HG	Al	56	1.37x4.00	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Sch	1½	1420*	33½	33 7/16	66	15
45	......	......	HG	Al	56	1.37x4.00	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Hol	2	1325*	33½	33 7/16	66	16
45	......	......	HG	Al	62	1.37x4.00	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Hol	2	1325*	26¼	37 5/16	66	17
45	......	......	HG	Al	62	1.37x4.00	4	AS	11¼	84	NS	Y	2.87x2.00	4	3.00x3.00	3.00x3.62	ab	18 mm	Sch	1½	1420*	33½	33 7/16	66	18
45	......	......	HG	Al	56	1.37x4.00	4	AS	11¼	85	CS	Y	2.87x2.25	4	3.00x3.00	3.00x3.62	abr	18 mm	Zen(2)	2	1325*	25	33 7/16	66	19
45	......	......	HG	Al	56	1.37x4.00	4	AS	11¼	85	CS	Y	2.87x2.25	4	3.00x3.00	3.00x3.62	abr	18 mm	Zen(2)	2	1450*	25	33 7/16	66	20
45	Bo	Tun	HG	Al	......	.750x2.84	3	AS	7	17	CS	Y	2.00x1.75	3	2.50x1.37	2.00x1.96	abc	18 mm	Str(2)	1	660*	23½	32⅜	42⅝	21
45	Bo	Tun	HG	CAS	......	.750x2.84	3	DFS	7	18	CAS	Y	2.14x1.75	3	2.50x1.37	2.00x1.96	abc	14 mm	Hol	1	700*	23½	32⅞	43 1/16	22
45	Bo	Tun	HG	CAS	15	.750x2.48	3	DFS	7 13/16	22	CAS	Y	2.12x1.57	4	2.40x1.83	2.40x2.25	abc	14 mm	Str	1	......	25⅜	31⅞	49 11/16	23
45	......	......	HG	Al	49	1.25x3.68	4	AS	10⅞	164‡	NS	Y	2.75x2.25	4	3.25x2.25	3.25x2.25	abc	18 mm	Hol	2	1700*	35	33½	58½	24
45	......	......	HG	Al	49	1.25x3.68	4	AS	10⅞	164‡	NS	Y	2.75x2.25	4	3.25x2.25	3.25x2.25	abc	18 mm	Str(2)		1700*	33¼	30 7/16	58½	25
45	......	......	HG	Al	49	1.25x3.68	4	AS	10⅞	164‡	NS	Y	2.75x2.25	4	3.25x2.25	3.25x2.25	abc	18 mm	Str(2)	2	1700*	33¼	30 7/16	58½	26
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1½	1400	27½	33½	71¾	27
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1½	1400	27½	33½	71¾	28
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1½	1850	27½	33½	71¾	29
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1¾	1400	27½	33½	71¾	30
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1½	2000	27 1/16	23	81 1/16	31
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1¾	2000	27½	33½	71¾	32
45	E	T-12	HG	Al	94	1.43x4.37	4	CS	12½	113	CNS	Y	2.50x2.12	7	3.00x1.75	3.00x2.87	abcdef	⅞-18	Zen(2)	1½	2000	27½	33½	71¾	33
60	N	......	HG	Al	100	1.25x5.12	3	CS	14	130	CNS	Y	2.50x3.00	4	2.50x4.43	2.50x4.43	abcdef	⅞-18	Zen(2)	1¾	2250	30½	45⅛	87½	34
60	N	......	HG	Al	100	1.25x5.12	3	CS	14	130	CNS	Y	2.50x3.00	4	2.50x4.43	2.50x4.43	abcdef	⅞-18	Zen(2)	1¾	2000	30½	45⅛	87½	35
60	N	......	HG	Al	110	1.25x5.12	3	CS	14	130	CNS	Y	2.50x3.00	4	2.50x4.43	2.50x4.43	abcdef	⅞-18	Zen(2)	2½	2175	30½	45⅛	87½	36
45	E	T-12	Ch	Al	280	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	7	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(3)	2½	7100	40⅛	72¾	121⅜	37
45	E	T-12	Ch	Al	290	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	7	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(3)	2½	7100	40⅛	72¾	121⅜	38
45	E	T-12	Ch	Al	290	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	7	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(3)	2½	7100	40⅛	72¾	121⅜	39
45	E	T-12	Ch	Al	280	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	9	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(4)	2½	9000	40⅛	72¾	142⅜	40
45	E	T-12	Ch	Al	290	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	9	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(4)	2½	9000	40⅛	72¾	142⅜	41
45	E	T-12	Ch	Al	290	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	9	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(4)	2½	9000	40⅛	72¾	142⅜	42
45	E	T-12	Ch	Al	......	2.00x7.00	4	CS	18	416	CNS	Y	4.00x3.12	9	4.00x3.37	4.00x5.50	abcdef	⅞-18	Zen(4)	2½	9900	44	64	144½	43
45	Bo	JM	HG	Al	96	1.62x5.90	6	4340	‡‡	48	4140	Y	3.50x2.87	7	4.00x3.00	4.00x3.00	abce	⅝-24	Str	....	4200	50	50	108⅝	44
45	Bo	JM	HG	Al	96	1.62x5.90	6	4340	‡‡	48	4140	Y	3.50x2.87	7	4.00x3.00	4.00x3.00	abce	⅝-24	Str	....	3950	50	50	108⅝	45
45	N	......	HG	CIA	64	1.10x3.25	3	1045	8½	43	1045	N	1.50x2.12	2	1.50x3.00	1.50x3.00	Splash	⅞-18	Str	1	415	19½	22 11/16	36¼	46
45	N	......	HG	CIA	19	.625x2.40	3	1045	8	27	1045	N	1.75x1.50	2	1.76x2.81	1.73x2.87	abe	⅞-18	Str	¾	330	15⅞	21⅛	38⅛	47
45	N	......	HG	CI	30	.875x2.75	3	1045	7¼	29	1045	N	1.75x1.25	3	2.12x1.43	2.12x1.18	abcde	18 mm	Str	1	490	21⅜	24 5/16	35	48
45	E	CA	HG	CI	45	1.10x3.06	4	1045	8¾	46	1045	N	2.00x1.50	3	2.00x2.50	2.00x1.87	abcde	⅞-18	Str	1	610	19⅛	26¼	41	49
45	N	......	HG	CIA	64	1.10x3.25	3	1045	8½	43	1045	N	1.50x2.12	3	1.50x3.00	1.50x3.00	abe	⅞-18	Str	1	620	19½	22 11/16	46⅝	50
45	N	......	HG	CIA	69	1.10x3.56	4	1045	10⅝	66	1045	N	2.00x2.25	3	2.00x4.18	2.00x3.50	abe	⅞-18	Str	1¼	830	20¼	26 11/16	54⅜	51
45	N	......	HG	CIA	89	1.10x3.93	4	1045	10⅝	66	1045	N	2.00x2.25	3	2.00x4.18	2.00x3.50	abe	⅞-18	Str	1½	830	20¼	26 11/16	54⅜	52
45	N	......	HG	CIA	82	1.25x3.87	4	1045	11⅜	87	1045	N	2.56x2.25	5	2.56x4.25	2.56x4.25	abce	⅞-18	Str	1½	1175	22¾	27 5/16	59 5/16	53
45	N	......	HG	CIA	126	1.43x4.68	4	1045	13¼	168	1045	N	2.56x3.00	5	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	1720	25⅞	37⅜	74 1/16	54
45	N	......	HG	CIA	150	1.43x5.25	4	1045	13¼	168	1045	N	2.56x3.00	5	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	1730	25⅞	37⅜	74 1/16	55
45	N	......	HG	CIA	190	1.43x5.50	4	1045	13¼	168	1045	N	2.56x3.00	5	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	1740	25⅞	37⅜	74 1/16	56
45	E	CA	HG	Al	37	1.00x3.50	4	1045	8	40	1045	N	2.00x1.50	7	2.62x2.00	2.62x1.25	abcde	18 mm	Str	1¼	1000	22½	28¼	53 11/16	57
45	E	CA	HG	Al	48	1.00x4.00	4	1045	8¾	48	1045	N	2.25x1.50	7	2.62x2.75	2.62x1.62	abcde	14 mm	Str	1¼	1185	20¼	27⅞	57 11/16	58
45	N	......	HG	CIA	82	1.25x3.87	4	1045	11⅜	87	1045	N	2.56x2.25	7	2.56x4.25	2.56x4.25	abce	⅞-18	Str	1½	1475	23⅜	33¼	72 5/16	59
45	N	......	HG	CIA	106	1.25x4.31	4	1045	11⅜	87	1045	N	2.56x2.25	7	2.56x4.25	2.56x4.25	abce	⅞-18	Str	2	1565	24⅛	33¼	72¾	60
45	N	......	HG	CIA	126	1.43x4.68	4	1045	13¼	168	1045	N	2.56x3.00	7	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	2330	27⅛	37⅜	91⅜	61
45	N	......	HG	CIA	150	1.43x5.25	4	1045	13¼	168	1045	N	2.56x3.00	7	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	2360	27⅛	37⅜	91⅜	62
45	N	......	HG	CIA	190	1.43x5.50	4	1045	13¼	168	1045	N	2.56x3.00	7	2.62x4.50	2.62x4.50	abcde	⅞-18	Str	2	2380	27⅛	37⅜	91⅜	63
45	N	......	HG	CI	......	1.00x3.75	3	Al	8½	......	CS	Y	2.00x2.00	2	2.00x2.00	2.00x2.00	Splash	18 mm	Str	⅝	200	15 5/16	24⅜	17 5/16	64
45	N	......	HG	Als	15	.750x2.56	4	CS	7¼	26	CS	Y	1.75x1.37	2	1.75x1.87	1.75x2.00	abce	18 mm	Zen	⅝	300	20 7/16	22⅝	28⅛	65
45	N	......	HG	CI	19	.625x2.44	3	CS	7½	22	CS	N	1.50x1.75	2	1.50x2.75	1.50x2.75	abce	18 mm	Zen	1	347	17 5/16	21 7/16	34 11/16	66
45	N	......	HG	Al	15	.750x2.56	4	Al	7¼	18	CS	Y	1.75x1.37	3	1.75x2.50	1.75x2.50	abce	18 mm	Zen	1	400	19 5/16	22⅝	34 11/16	67
45	N	......	HG	Al	20	.875x2.75	4	Al	8½	30	CS	N	2.00x1.75	3	2.00x2.50	2.00x2.50	abc	18 mm	Zen	1	520	18½	25¼	39⅝	68
45	N	......	HG	Al	15	.750x2.56	4	Al	7¼	18	CS	Y	1.75x1.37	4	1.75x2.50	1.75x2.50	abce	18 mm	Zen	1¼	515	24	20¾	43⅞	69
45	N	......	HG	Al	28	.875x3.00	4	Al	8½	28	CS	N	2.00x1.87	7	2.00x2.56	2.00x2.56	abce	18 mm	Str	1¼	775	20 1/16	28¾	49 11/16	70
45	N	......	HG	Al	28	.875x3.00	4	Al	8½	28	CS	N	2.00x1.87	7	2.00x2.56	2.00x2.56	abce	18 mm	Str(2)	1¼	810	22 5/16	28¾	49 11/16	71
45	N	......	HG	Al	28	.875x3.00	4	Al	8½	28	CS	N	2.00x1.87	9	2.00x2.56	2.00x2.56	abce	18 mm	Str	1¾	1050	21 5/16	26 5/16	62⅝	72
45	N	......	HG	Al	28	.875x3.00	4	Al	8½	28	CS	N	2.00x1.87	9	2.00x2.56	2.00x2.56	abce	18 mm	Str(2)	1½	1100	22¾	26 5/16	62⅝	73
45	N	......	HG	CI	......	.625x2.62	4	1045	4⅝	12	1045	Y	1.50x1.00	2	1.50x1.00	2.25x2.31	abcde	14 mm	Op	⅝	125	20¾	14⅛	15⅝	74
45	N	......	HG	Al	8	.625x2.12	4	1045	6	14	1045	N	1.56x1.25	2(9)	ND1207	ND1207	abcde	14 mm	Op	⅝	143	14 11/16	20½	21 11/16	75
45	E	CA	HG	CI	25	.875x2.25	4	1045	7¼	29	1045	N	1.75x1.06	3	2.12x1.18	2.12x1.43	abcde	18 mm	Op	1	280	19	26¾	27¾	76
45	E	CA	HG	CI	30	.875x2.75	4	1045	7¼	29	1045	N	1.75x1.06	3	2.12x1.18	2.12x1.43	abcde	18 mm	Op	1	290	19	26¾	27¼	77
45	N	......	HG	CI	43	.875x2.68	5	1045	6	28	1045	N	2.00x1.37	3	2.25x1.62	2.25x1.62	a	18 mm	Op	1	335	17¼	25⅜	20½	78
45	E	CA	HG	CI	45	1.12x3.03	4	1045	8¾	46	1045	N	2.00x1.50	3	2.00x1.87	2.00x2.50	abcde	⅞-18	Op	1	385	17⅞	27	32⅞	79
(h)	E	CA	HG	CI	58	1.12x3.06	4	1045	8¾	57	1045	N	2.25x1.75	3	2.62x1.75	2.62x2.25	abcdeg	18 mm	Op	1¼	670	21½	38¾	33 5/16	80
(h)	E	CA	HG	CI	69	1.12x3.31	4	1045	8¾	57	1045	N	2.25x1.75	3	2.62x1.75	2.62x2.25	abcdeg	18 mm	Op	1¼	680	21½	38¾	33 5/16	81
45	E	CA	HG	CI	76	1.31x3.87	4	1045	10½	86	1045	N	2.37x2.12	3	2.37x2.12	2.37x2.75	abcdeg	⅞-18	Op	1¼	875	21¼	35	37⅞	82
45	E	CA	HG	CI	85	1.31x4.06	4	1045	10½	86	1045	N	2.37x2.12	3	2.37x2.12	2.37x2.75	abcdeg	⅞-18	Op	1¼	925	21¼	35	37⅞	83
45	E	CA	HG	CI	96	1.31x4.06	4	1045	10½	85	1045	N	2.37x2.12	3	2.37x2.31	2.37x2.75	abcdeg	18 mm	Op	1¼	1025	20¼	37 11/16	39 5/16	84
45	E	CA	HG	Al	32	1.00x3.12	4	1045	8	40	1045	N	2.00x1.50	7	2.62x1.25	2.62x2.00	abcde	18 mm	Op	1¼	675	19¼	31	39½	85
45	E	CA	HG	Al	34	1.00x3.25	4	1045	8	40	1045	N	2.00x1.50	7	2.62x1.25	2.62x2.00	abcde	18 mm	Op	1¼	685	19¼	31	39½	86
45	E	CA	HG	Al	37	1.00x3.50	4	1045	8	40	1045	N	2.00x1.50	7	2.62x1.25	2.62x2.00	abcde	18 mm	Op	1½	690	19¼	31	39½	87
45	E	CA	HG	Al	46	1.00x3.85	4	1045	8	40	1045	N	2.00x1.50	7	2.62x1.25	2.62x2.00	abcde	18 mm	Op	1½	706	19¼	31	39½	88
45	E	CA	HG	Al	45	1.00x3.85	4	1045	8¾	45	1045	N	2.25x1.50	7	2.62x1.62	2.62x2.75	abcde	18 mm	Op	1½	890	20⅞	34¾	43 11/16	89
45	E	CA	HG	Al	45	1.00x4.00	4	1045	8¾	48	1045	N	2.25x1.50	7	2.62x1.62	2.62x2.75	abcde	18 mm	Op	1¾	920	20⅞	34¾	43 11/16	90
(h)	E	CA	HG	Al	60	1.37x3.62	4	1045	10¼	85	1045	N	2.62x2.00	7	3.25x1.75	3.25x3.00	abcdeg	18 mm	Op	1¾	1350	23⅝	41 11/16	50⅝	91

(For abbreviations see pages 138-139)

American Gasoline

Line Number	ENGINE MAKE AND MODEL	Designed for	Number or Cylinders, Bore and Stroke (In.)	MAXIMUM BRAKE Hp. at Specified R.P.M. — With Bare Engine	With Standard Accessories	Piston Displacement (Cu. In.)	Compression Ratio	Maximum Torque at R.P.M. (Lb. Ft., with or without Accessories	Cylinder Liners—Type	Crankcase—Upper Half Integral with Cylinders	VALVES — Arrangement	Exhaust Head Material (S.A.E. No.)	Max. Head Diameter (In.) Intake	Exhaust	Min. Port Diameter (In.) Intake	Exhaust	Lift (In.) Intake	Exhaust	Stem Diameter (In.) Intake	Exhaust
1	Waukesha........(11) 6SRLR	T, B, Ind	6-4 3/8x5 1/8	112-2250	105-2256	462.0	5.50	330-600 (BE)	N	Se	L	Sil	2.16	1.65	1.87	1.37	.386	.375	.375	.375
2	Waukesha........(11) 140-GK	T, B, Ind	6-4 1/2x5 1/2	136-2250	128-2250	525.0	5.80	403-1000 (BE)	W	In	I	Sil	2.12	1.56	1.87	1.37	.531	.469	.434	.434
3	Waukesha........(11, 6SRKR	T, B, Ind	6-4 5/8x5 1/8	125-2250	120-2250	517.0	5.50	369-600 (BE)	N	Se	L	Sil	2.16	1.65	1.87	1.37	.386	.375	.375	.375
4	Waukesha........(11) 145-GS	T, B, Ind	6-4 3/4x6	152-2000	143-2000	638.0	5.60	481-1000 (BE)	W	In	I	Sil	2.37	1.84	2.12	1.62	.594	.531	.500	.500
5	Waukesha........(11) 145-GK	T, B, Ind	6-5 1/4x6	186-2000	177-2000	779.0	5.60	590-1200 (BE)	W	In	I	Sil	2.37	1.84	2.12	1.62	.594	.531	.500	.500
6	Waukesha........(12) 6WAL	T, B, Ind	6-5 3/4x6 1/2	200-1800	162-1300	1013.0	5.00	735-800 (BE)	W	In	I	Sil	2.65	2.22	2.37	2.00	.656	.656	.500	.500
7	Waukesha........(12) 6WAK	T, B, Ind	6-6 1/4x6 1/2	235-1800	193-1300	1197.0	5.20	865-900 (BE)	W	In	I	Sil	2.65	2.22	2.37	2.00	.656	.656	.500	.500
8	Waukesha........(12) 6EL	Ind	6-6 1/2x7	165-1125	144-1050	1395.0	4.00	1000-550 (BE)	W	In	I	Sil	2.84	2.53	2.50	2.25	.718	.718	.562	.562
9	Waukesha........(12) 6EK	Ind	6-7x7	190-1125	166-1050	1616.0	4.00	1120-550 (BE)	W	In	I	Sil	2.84	2.53	2.50	2.25	.718	.718	.562	.562
10	Waukesha........(12) 6NK	Ind	6-7x8 1/2	221-1050	196- 950	1962.0	5.50	1330-600 (BE)	W	In	I	Sil	2.84	2.53	2.50	2.25	.718	.718	.562	.562
11	Waukesha........(12) 6LRO	Ind	6-8 1/2x8 1/2	337-1050	300- 900	2894.0	3.80	1870-700 (BE)	N	Se	I	Sil	3.50	3.00	3.25	2.75	.750	.840	.562	.562
12	Waukesha........FCL	Tr, Ind	4-3x4	28-2600	23-2600	113.0	5.75	73-1200	N	In	L	Sil	1.34	1.34	1.18	1.18	.281	.281	.312	.312
13	White........100A	T, B	6-3 7/16x4 1/2	90-2800	....	250.0	6.75	185-1200 (BE)	N	In	L	St	1.65	1.62	1.43	1.50	.381	.381	.375	.375
14	White........110A	T, B	6-3 9/16x4 1/2	100-2600	....	270.0	6.50	200-1300 (BE)	N	In	L	St	1.65	1.62	1.43	1.50	.381	.381	.375	.375
15	White........120A	T, B	6-3 7/8x4 1/2	110-2600	....	318.0	6.40	285-1200 (BE)	N	In	L	Sil°(x)	1.65	1.62	1.43	1.50	.381	.381	.375	.437
16	White........140A	T, B	6-3 7/8x5 1/8	125-2600	....	362.0	6.28	285-1100 (BE)	N	In	L	Sil°(x)	1.65	1.62	1.75	1.50	.381	.381	.375	.437
17	White........(H) 140TA	B	6-3 7/8x5 1/8	....	125-2800	362.0	6.28	250-1200 (BE)	N	In	L	Sil°(x)	.....	.....	1.75	1.50	.375	.381	.....	.....
18	White........(H) 24A	B	12-4 1/8x4 1/4	....	209-2600	681.0	5.65	500-1200 (BE)	D	In	L	Sil°(x)	.....	.....	1.62	1.62	.375	.375	.....	.....
19	Willys........442	C, T	4-3 1/8x4 3/8	63-3900	....	134.2	6.48	108-1800 (BE)	N	In	L	CNS	1.53	1.46	1.34	1.28	.351	.351	.373	.373
20	Wisconsin........AK	M, Tr, Ind	1-2 7/8x2 3/4	4.2-2400	4.2-2400	17.8	4.59	9.5-1700 (EA)	N	In	L	AUS	1.12	1.12	.937	.937	.187	.187	.310	.310
21	Wisconsin........AHH	M, Tr, Ind	1-3 5/8x4	9.2-2200	9.2-2200	41.3	4.50	26-1300 (EA)	N	Se	L	Sil	1.56	1.56	.812	1.25	.275	.275	.310	.310
22	Wisconsin........AC-4	Tr, Ind	4-2 5/8x3 1/4	16-2600	16-2600	70.4	4.60	39.5-1600 (EA)	N	Se	I	Sil	1.12	1.12	.937	.937	.232	.232	.310	.310
23	Wisconsin........VE-4	M, Tr, Ind	4-3x3 1/4	22-2600	22-2600	91.9	4.60	50-1700 (EA)	N	Se	L	AUS	1.31	1.31	1.12	1.12	.275	.275	.310	.310
24	Wisconsin........AM-4	Tr, Ind	4-3 1/4x4	25-2200	25-2200	132.0	4.56	79-1300 (EA)	N	Se	I	Sil	1.50	1.37	1.12	1.12	.276	.256	.310	.310
25	Wisconsin........AP-4	Tr, Ind	4-3 1/2x4	32-2100	32-2100	154.0	4.60	94-1100 (EA)	N	Se		Sil	1.50	1.37	1.12	1.12	.276	.256	.310	.310
26	Wisconsin........VF-4	M, T, Ind	4-3 1/4x3 1/4	25-2400	25-2400	107.7	4.60	57-1600	N	Se	L	AUS	1.31	1.31	1.12	1.12	.275	.275	.310	.310
27	Wisconsin........	....	For other	engines	see SMA	LL GA	SOLI	NE POWER U	NI	TS	tab	le								

ABBREVIATIONS

§—Used in Bus engines; no liners used in truck engines °—Stellite faced
*—Weight complete with ignition and carburetor
**—Pressure also to Camshaft thrust bearing
■—Also available in reduction gear models
▼—Also available in R.H. rotation
‡—Tocco hardened ♠—Weight per pair
†—Rated with generator and water pump, but no fan or muffler
††—1500 lbs. for model 179; model 178 includes reduction gear and weighs 1905 lbs. complete
‡—Super-Charged engine
‡‡—8¾ in. for link rod; 12 in. for master rod
(1)—6.20 ratio for Cars, 5.90 for heavy duty truck engine
(3)—Three used (2)—Two used
(4)—Four used
(5)—156 ft. lb. torque at 2200 for cars; 156 ft. lb. at 2000 for heavy duty truck engine
(6) 41⅜ in. for 178 model; 36⅞ in. for 179 model
(7)—76 7116 in. for 178 model; 62⅝ in. for 179 model
(8)—Minneapolis Moline Power Implement Co. (9)—Ball Bearings
(10)—Red Wing Motor Co.
(11)—Automotive Power Ratings
(12)—Industrial Power Ratings
a—Main Bearings
(aa)—Forked rod, 88 oz.; Plain Rod, 50 oz. Al—Aluminum Alloy
Ala—Aluminum Alloy, Anodized
Als—Aluminum Alloy with Steel Strut
AS—Alloy Steel
AUS—Austenitic Steel B—Buses
Ay—Alloy Iron
b—Connecting Rods (BE)—Bare Engine
BG—Bevel Gear
Bo—Used in both Intake and Exhaust seats
c—Camshaft Bearings C—Cars
CA—Cast Alloy. Car—Carter Carburetor
CAS—Cast Alloy Steel Ch—Chain
CHS—Chrome Nickel Silicon Steel
CI—Cast Iron CIA—Cast Iron, Anodized
CM—Chrome Molybdenum
CMT—Chromium Tungsten Steel
CNI—Chrome Nickel Iron
CNM—Chrome Nickel Molybdenum
CNS—Chrome Nickel Steel
CNT—Chrome Nickel Steel with Tungsten

AIRCRAFT AUXILIARY POWER PLANT GASOLINE ENGINES

MAKE AND MODEL	Number of Cycles	Cooling Medium	CYLINDERS — Number	Material	Arrangement	ENGINE — Bore and Stroke (In.)	Total Displacement (Cu. In.)	Horsepower — Maximum at R.P.M.	Continuous at R.P.M.	Compression Ratio (to—1)	Valve Arrangement	GENERATOR OUTPUT — Drive	At Continuous Rating — Watts	Volts	At Altitude	Watts	Volts	AC or DC Current	Weights — Installation (Lb.)	Lb. per Watt (At Cont. Rating)	Ignition System — Type	Make	Starting Method
Andover (1)........V32	4	A	2	SA	Vee	2 3/4x2 11/16	31.9	15@3200	10@3200	7.80	I	G	5000	28.5	5,000	4500	28.5	DC	121	.024	Mag	Wic	MG,H
Eclipse (2)........542	2	A	1	AS	Ver	2 1/2x2 1/4	12.3	4.5@4200	4@4000	....	N	D	1800(a)	28.5(b)	....	....	....	AD	100	.042	Mag	Scin	H
Lawrence (3)......30C-1	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	....	9.00	I	D	5000	30.0	20,000	2850	30.0	DC	212	....	Mag	Scin	HB
Lawrence........30C-2	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	....	9.00	I	D	5000	30.0	20,000	2850	30.0	DC	212	....	Mag	Scin	HB
Lawrence........30C-4A	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	....	9.00	I	D	5000	30.0	20,000	2850	30.0	DC	184	....	Mag	Scin	HB
Lawrence........30C-5	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	....	9.00	I	D	5000	30.0	N	N	N	DC	179	....	Mag	Scin	HB
Lawrence........30D	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	10@....	9.00	I	D	Gover	nment F	urnished	Equipm	ent	.....	186	....	Mag	Scin	H
Lawrence........30D-1	..	A	2	AF	Hor	2 5/8x2 3/4	30.0	15@4100	....	9.00	I	D	Gover	nment F	urnished	Equipm	ent	.....	212	....	Mag	Scin	H
Lawrence........75A	..	A	5	AF	Rad	2 5/8x2 3/4	75.0	37@4050	....	9.00	I	D	2000(c)	30.0(c)	20,000	2000(d)	30.0(d)	AD	452	....	Mag	Scin	HB
Lawrence........75B	..	A	5	AF	Rad	2 5/8x2 3/4	75.0	37@4050	....	9.00	I	D	8000	30.0	20,000	8000	30.0	DC	308	....	Mag	Scin	HB
Lawrence........75A	..	A	5	AF	Rad	2 5/8x2 3/4	75.0	37@4050	....	9.00	I	D	2000(e)	30.0(e)	20,000	2000(f)	30.0(f)	AD	443	....	Mag	Scin	HB
Lawrence........20A	..	A	2	AF	Hor	2 5/8x2 1/4	20.0	15@6000	....	8.50	I	D	5000	28.5	10,000	4500	28.5	DC	111	....	Mag	Wic	HB
Onan (4)........OTC-80	4	A	2	Alu	Op	2 3/4x2 1/4	26.7	4.5@2850	4.4@2800	6.00	L	D	2000	28.5	SL	2000	28.5	DC	115	.057	Mag	Own	BR
Onan........OFA-15	4	A	4	CI	Op	2 3/4x2 1/4	53.5	9@2850	8.2@2250	6.00	L	D	5000	28.5	SL	5000	28.5	DC	300	.060	Bat	AL	BR

ABBREVIATIONS

A—Air (a)—DC or 600 AC
AD—Alternating or Direct Current
AF—Aluminum and Drop Forged Steel
Alu—Aluminum
AL—The Electric Auto-Lite
AS—Aluminum with Alloy Steel Liner
(b)—DC or 120 AC
Bat—Battery BR—Battery or Rope
(c)—DC or 6750 Watts at 120 Volts AC
CI—Cast Iron D—Direct
(d)—DC or 1000 Watts at 120 Volts AC
DC—Direct Current
(e)—DC or 6750 Watts at 120 Volts AC
(f)—DC or 6000 Watts at 120 Volts AC
G—Geared
H—Hand (Rope and Pulley)
HB—Hand or Battery
Hor—Horizontal
I—In-Head (valves)
L—L-Head (valves)
Mag—Magneto
MG—Motorizing Generator
N—No or None
Op—Opposed
Rad—Radial
SA—Steel barrel, aluminum head
SL—Sea Level
Scin—Scintilla Magneto Division
Ver—Vertical
Wic—Wico Electric Co.
(1)—Andover Motors Corporation
(2)—Eclipse-Pioneer Div.; Bendix Aviation Corp.
(3)—Lawrence Aeronautical Corporation
(4)—D. W. Onan & Sons

Engines—Concluded

Valves: Seats: Angle (Deg.)	Valves: Seats: Inserts Used?	Valves: Seats: Insert Material (S.A.E. No.)	Camshaft Drive—Type	Pistons: Material	Pistons: Weight with Pins, Rings, Bushings (Oz.)	Pistons: Piston Pin—Diameter and Length (In.)	Number of Rings per Piston	Connecting Rods: Material	Connecting Rods: Center to Center Length (In.)	Connecting Rods: Weight with Bushing and Cap (Oz.)	Crankshaft: Material	Crankshaft: Counter Balance Used	Crankshaft: Crank-Pin Diameter and Length (In.)	Crankshaft: Main Bearings: Number	Crankshaft: Main Bearings: Diameter and Length (In.) Front	Crankshaft: Main Bearings: Diameter and Length (In.) Rear	Oil Pressure to—	Spark Plug—Thread Size	Carburetor: Make	Carburetor: Size	Engine Weight without Carburetor or Ignition (Lb.)	Overall Dimensions (In.): Width	Overall Dimensions (In.): Height	Overall Dimensions (In.): Length	Line Number
30	E	CA	HG	Al	89	1.37x4.00	4	1045	10¼	83	1045	N	2.75x1.75	7	3.00x1.87	3.00x3.00	abcde	⅞-18	Op	1¾	1185	24⅛	39⅛	46 9/16	1
(h)	E	CA	HG	Al	64	1.37x3.87	4	1045	10¼	85	1045	N	2.62x2.00	7	3.25x1.75	3.25x3.00	abcdeg	18 mm	Op	1¾	1390	23⅝	41 13/16	50⅜	2
30	E	CA	HG	Al	70	1.37x4.25	4	1045	10¼	83	1045	N	2.75x1.75	7	3.00x1.87	3.00x3.00	abcde	⅞-18	Op	1¾	1225	24⅛	39⅜	46 9/16	3
(h)	E	CA	HG	Al	.....	1.62x4.37	4	1045	11¾	133	1045	N	3.00x2.25	7	3.50x2.00	3.50x3.50	abcdeg	18 mm	Op	2	1900	25¾	46⅜	55 13/16	4
(h)	E	CA	HG	Al	103	1.62x4.87	4	1045	11¾	133	1045	N	3.00x2.25	7	3.50x2.00	3.50x3.50	abcdeg	18 mm	Op	2	1930	25¾	46⅜	55 13/16	5
(h)	E	CA	HG	CI	262	1.87x5.00	4	1045	13¼	195	1045	N	3.37x2.37	7	4.00x2.56	4.00x3.56	abcdeg	18 mm	Op	2½	3000	30⅝	50⅞	65⅝	6
(h)	E	CA	HG	CI	292	1.87x5.50	4	1045	13¼	195	1045	N	3.37x2.37	7	4.00x2.56	4.00x3.56	abcdeg	18 mm	Op	2½	3050	30⅝	50⅞	65⅝	7
(h)	E	CA	HG	CI	.....	2.00x6.00	4	1045	15⅜	314	1045	N	3.25x2.75	7	3.75x3.75	3.75x5.50	abcdeg	18 mm	Op	2½	5675	31 13/16	60⅝	76	8
(h)	E	CA	HG	CI	304	2.00x6.00	4	1045	15⅜	314	1045	N	3.25x2.75	7	3.75x3.75	3.75x5.50	abcdeg	18 mm	Op	2½	5700	31 13/16	60⅝	76	9
(h)	E	CA	HG	CI	304	2.00x6.00	4	1045	15⅜	314	1045	N	3.25x2.75	7	3.75x3.75	3.75x5.50	abcdeg	18 mm	Op	2½	5900	31 13/16	61 13/16	76	10
30	E	CA	HG	CI	776	2.25x7.75	5	1045	18⅜	474	1045	N	4.00x3.75	7	4.25x4.81	4.25x5.50	abcdeg	⅞-18	Op(2)	2½	10640	48½	65	95⅛	11
45	E	CA	HG	CI	112	.875x2.50	4	1045	7¼	29	1045	N	1.75x1.06	3	2.12x1.18	2.12x1.43	abcde	18 mm	Op	1	285	19	26¾	27¾	12
45	E	St	HG	Al	38	1.00x3.03	5	1040	9 15/32	40	1050	Y	2.18x1.34	7	3.00x1.84	3.00x1.93	abcde	14 mm	Str(Dp)	1¼	973	29⅜	40⅝	44¼	13
45	E	St	HG	Al	43	1.00x3.03	5	1040	9 15/32	52	1050	Y	2.18x1.34	7	3.00x1.84	3.00x1.93	abcde	14 mm	Str(Dp)	1¼	973	29⅜	40⅝	44¼	14
45	E	St	HG	Al	45	1.00x3.46	5	1040	9 15/32	52	1050	Y	2.18x1.34	7	3.00x1.84	3.00x1.93	abcde	14 mm	Str(Dp)	1¼	993	29⅜	40⅝	44¼	15
45	E	St	HG	Al	45	1.00x3.46	5	1040	9 15/32	52	1040	Y	2.18x1.34	7	3.00x1.84	3.00x1.93	abcde	14 mm	Str(Dp)	1¼	1051	29⅜	40⅝	44¼	16
45	E	St	HG	Al	45	1.00x3.46	5	....	9 15/32	52	......	Y	2.18x1.34	7	3.00x1.84	3.00x1.93	abcdef	18 mm	Str(Dp)	1¼	1280*	.....	.....	.....	17
....	E	St	HG	Al	30	1.18x-.—	5	....	8 1/32	.....	......	Y	2.43x2.31	7	2.87x2.09	2.87x2.40	abcdef	18 mm	Zen(Dp)	....	2275*	.....	.....	.....	18
45	N	N	Ch	CI	24	.812x2.78	3	MS	9 3/16	34	1040	Y	1.94x1.30	3	2.33x1.92	2.33x1.75	abce	14 mm	Car	1¼	364	19	26⅜	26¼	19
45	E	Mo	HG	Al	10	.625x2.37	4	Al	6	6	1045	Y	1.00x1.00	2	(9)	(9)	....	18 mm	Str	⅝	70*	17¾	16¾	15	20
45	Bo	Mo	HG	Al	26	.937x3.00	4	1035	9½	33	1045	Y	1.37x1.37	2	(9)	(9)	....	18 mm	Str	1	180*	18⅞	24⅜	18⅛	21
45	Bo	Mo	HG	CI	14	.875x2.17	4	1035	8⅜	21	1045	Y	1.75x1.12	2	(9)	(9)	g	18 mm	Str	¾	230*	17	26¼	29	22
45	Bo	Mo	HG	CI	22	.750x2.56	4	1035	8⅜	21	1045	N	1.37x1.12	2	(9)	(9)	....	18 mm	Str	⅞	285*	21½	25½	25⅜	23
45	Bo	Mo	HG	CI	30	.937x2.75	4	1035	8⅜	29	1045	N	1.75x1.25	3	(9)	(9)	ag	18 mm	Str	1	340*	20	29	36⅜	24
45	Bo	Mo	HG	CI	35	.937x2.75	4	1035	8⅜	29	1045	N	1.75x1.25	3	(9)	(9)	ag	18 mm	Str	1	345*	20	29	36⅜	25
45	Y	MI	HG	CI	68	.750x2.56	4	1045	8⅜	21	1045	N	1.37x1.12	2	Timken	Roller	Splash	18 mm	Str	⅞	285*	21½	25½	25⅞	26
								For	other	engin	es see	SM	ALL GAS	OL	INE POW	ER UNIT	S table								

ABBREVIATIONS—Cont.

CS—Carbon Steel
CSC—Carbon Steel, Case Hardened
CT—Cast Iron, Tin plated
d—Wrist Pins D—Dry Liners
DC—Durachrome Casting
DFS—Drop Forged Steel
Dia—Diachrome Dp—Duplex
Dur—Duralumin
●—Timing Gears or Chain
E—Used on Exhaust valve seats
(EA)—Engine with Standard Accessories
Ecl—Eclipse f—Accessories drive
Fa—Fire Apparatus
F—In Head and Side ("F" Head)
FA—Fire Apparatus
g—Rocker Arms and Shafts
(h)—Intake 30°, Exhaust 45°
(H)—Horizontal Motor
HC—Helical Gear and Chain
HG—Helical Gear
HH—Horizontal in Head (Valves)
Hol—Holley Carburetor
HS—High Speed Steel
I—In Head (Valves) In—Integral
Ind—Industrial Jad—Jadson 1-S
JM—Jadson 1-S material
(k)—Intake 30°, Exhaust 44°
L—Valves at Side (L-Head)
(m)—2 Engines—8 cylinders each
M—Marine MA—Molybdenum Alloy
MI—Moly Iron
ML—Mechanical Lubricator System
Mo—Molybdenum
MS—Manganese Steel N—No or none
NCI—Nickel Cast Iron
NIS—Nickel Cast Iron, Stellited
NS—Nickel Steel Op—Optional
PS—Pump Splash system
r—Reverse Gear RC—Rail Cars
SA—Special Alloy SB—Spiral Bevel Gear
Sch—Schebler Carburetor Se—Separate
SG—Spur Gear Sho—Shore Carburetor
Sil—Silcrome Steel
Spec—Special SS—Semi-Steel
St—Stellite Steel
Str—Stromberg Carburetor
t—Tappets and Valve Mechanism
T-12—Thompson Products No. 12
T—Valves, Opposite (T-Head)
T—Trucks TA—Tungsten Alloy
Til—Tilotson Carburetor
Tr—Tractors Tun—Tungsten Steel
W—Wet Liners WA—Wausau Alloy
WR—Wilcox-Rich-EA5
(x)—Sodium Cooled
Y—Yes Zen—Zenith Carburetor
ZC—Zenith or Carter

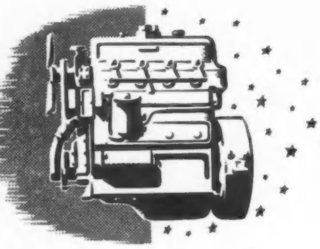
U. S. Exports of Automotive Products—1941

In the table below are shown for the first time automotive export data for the complete year 1941. Publication of all export data was suspended September 1941, but has just been resumed. Data for 1942 and 1943 will be published in the earliest possible issue.

	Number	Value
Passenger Cars and Chassis (New)		
Not over $850	62,315	$38,901,567
Over $850 and not over $1,200	16,386	15,624,184
Over $1,200 and not over $2,000	2,518	3,528,096
Over $2,000	557	2,694,731
Total	81,776	$60,748,578
Passenger Cars—Secondhand	2,693	1,292,967
Trucks, Busses and Chassis (New)		
Under 1 ton	22,801	13,334,659
1 ton and not over 1½ ton	83,641	58,785,847
Over 1½ ton and not over 2½ ton	23,699	32,188,992
Over 2½ ton		
Diesel	1,207	4,121,164
Gasoline	15,754	39,673,288
Bus Chassis	145	185,524
Total	147,247	148,289,474
Trucks and Busses—Secondhand	752	458,390
Trailers	2,241	2,502,703
Parts for assembly	......	67,894,339
Automotive Engines for Assembly		
Trucks and Bus—Diesel and Semi-Diesel	737	594,237
Truck and Bus—Gasoline	20,307	2,386,703
Passenger Car	7,023	910,758

	Number	Value
Automobile Engines for replacement		
Diesel and semi-Diesel	443	$349,315
Gasoline	3,356	647,173
Asbestos Brake Lining		
Molded and semi-molded	......	1,150,386
Not molded, Lin. ft.	1,277,562	285,192
Clutch Facing		
Molded and semi-molded	504,618	201,216
Woven	501,753	163,204
Auto Axle Shafts	45,069	152,954
Pistons	......	461,764
Piston Rings	......	1,029,595
Valves	......	154,116
Differential and Transmission Gears	......	655,117
Gears, n. e. s.	......	834,971
Spark Plugs	4,879,606	1,197,185
Auto and Truck Springs	......	1,166,044
Parts for replacement, n. e. s.	......	42,352,524
Horns, hand and electric	349,038	447,163
Auto accessories, n. e. s.	......	6,657,233
Garage and Service Station Equipment		
Automobile Tire equipment	......	1,068,599
Pumps for gasoline and oil	12,951	626,509
Other automobile service equipment	......	3,115,740

Note: Above figures do not include shipments to non-contiguous territories. All figures subject to further revision.



AUTOMOTIVE DIESEL

Line Number	ENGINE MAKE AND MODEL	Built Under License from	Designed for	Type	Number of Cylinders Bore and Stroke (In.)	Cylinder Liners—Type	Cycle	Piston Displacement (Cu. In.)	GENERAL: With Bare Engine: Maximum Brake Hp. at Specified R.P.M.	With Standard Accessories: Max. Intermittent Hp. at Specified R.P.M.	With Standard Accessories: Continuous Sustained Hp. at Specified R.P.M.	Compression Ratio - to 1	Max. Combustion Pressure (Lb. per Sq. In.)	B.M.E.P. at Continuous Hp. (Lb. per Sq. In.)	Weight per Continuous Hp. (Lb.)	Max. Torque in Lb. Ft. at Specified R.P.M.	Shipping Weight (Lb.): Automotive or Industrial	Shipping Weight (Lb.): Marine	VALVES: Arrangement	Intake Port Diameter and Lift (In.)
1	Atlas Imperial...1LN29	Lanova	I	AC	1-3⅛x3¾	W	4	29	6.5-1800	5.7-1800	5-1800	15.50	750	76	72.8♦	15-1100	364	....	VI	1.06- .390
2	Atlas Imperial...3LN29	Lanova	I	AC	3-3⅛x3¾	W	4	87	20-1800	16.5-1800	15-1800	15.50	750	76	40.3♦	45-1100	604	....	VI	1.06- .390
3	Buda........4-DT-212	Lanova	C,T,Tr,R	AC	4-3⅝x5⅛	D	4	212	60.5-2300	49-2300	37-1800	14.50	725	77	25.7♦	123.5-1400	950	....	VI	1.37- .486
4	Buda......4-DTM-212	Lanova	M	AC	4-3⅝x5⅛	D	4	212	60.5-2300	50-2100	40-1800	14.50	725	83	24.6	132-1400	....	985	VI	1.37- .486
5	Buda........4-DT-226	Lanova	C,T,Tr,R	AC	4-3¾x5⅛	D	4	226	58.5-2000	48-2000	39-1800	14.50	725	76	24.3♦	132-1400	950	....	VI	1.37- .486
6	Buda........6-DT-278	Lanova	C,T,Tr,B	AC	6-3⅝x4½	D	4	278	82-2600	69-2600	47-1800	14.50	725	74	23.5♦	161.8-1500	1105	....	VI	1.37- .486
7	Buda........6-DT-294	Lanova	C,T,Tr,B	AC	6-3⅝x4¾	D	4	294	85-2400	71-2400	51-1800	14.50	725	76	21.9♦	177 1500	1115	....	VI	1 37- .486
8	Buda........6-DT-317	Lanova	C,T,Tr,B	AC	6-3⅝x5⅛	D	4	317	90-2300	75-2300	52.5-1800	14.50	725	73	21.6♦	185.4-1500	1133	....	VI	1.37- .486
9	Buda......6-DTM-317	Lanova	M	AC	6-3⅝x5⅛	D	4	317	90-2300	75-2100	56-1800	14.50	725	78	22.3	195-1500	....	1250	VI	1.37- .486
10	Buda........6-DT-389	Lanova	T,Tr,B	AC	6-3⅞x5½	D	4	389	96-2100	74.5-2100	57-1600	14.20	725	73	24.5♦	222.5-1100	1400	....	VI	1.44- .476
11	Buda........6-DT-468	Lanova	T,Tr,B	AC	6-4¼x5½	D	4	468	113-2000	89-2000	68-1600	14.20	725	72	21.1♦	268.5-1100	1435	....	VI	1.59- .476
12	Buda......6-DTM-468	Lanova	M	AC	6-4¼x5½	D	4	468	113-2000	97-1800	75-1600	14.20	725	79	23.7	308-1100	....	1775	VI	1.59- .476
13	Buda........6-DH-691	Lanova	T,Tr,R	AC	6-4¾x6½	D	4	691	150-1800	123-1800	81-1200	13.70	725	77	28.0♦	404-1100	2270	....	VI	1.72- .516
14	Buda......6-DHM-691	Lanova	M	AC	6-4¾x6½	D	4	691	150-1800	125-1600	92-1300	13.70	725	81	29.3	432-1100	....	2700	VI	1.72- .516
15	Buda........6-DH-909	Lanova	Tr,R,I	AC	6-5¼x7	W	4	909	169-1500	143-1500	107-1200	13.60	725	77	30.4♦	534- 900	3250	....	VI	1.90- .540
16	Buda......6-DHM-909	Lanova	M	AC	6-5¼x7	W	4	909	169-1500	152-1500	117-1200	13.60	725	85	28.6	569- 900	....	3350	VI	1.90- .540
17	Buda.......6-D-H1611	Lanova	R,I	AC	6-6¼x8¾	W	4	1611	217-1100	176-1100	135- 900	13.00	725	75	50.9♦	917- 650	6875	....	VI	2.25- .687
18	Buda.......6-D-H1742	Lanova	R,I	AC	6-6½x8¾	W	4	1742	234-1100	192-1100	146- 900	13.00	725	74	47.3♦	991- 650	6900	....	VI	2.37- .687
19	Buda.......6-D-H1879	Lanova	R,I	AC	6-6¾x8¾	W	4	1879	248-1100	203-1100	155- 900	13.00	725	73	44.8♦	1043- 650	6950	....	VI	2.50- .687
20	Buda.....6-DHM-1879	Lanova	M	AC	6-6¾x8¾	W	4	1879	248-1100	222-1100	186-1000	13.00	725	78	34.9	1140- 650	....	6500	VI	2.50- .687
21	Buda.....6-PH-D1879	Lanova	I	AC	6-6¾x8¾	W	4	1879	248-1100	203-1100	155- 900	13.00	725	73	58.1♦	1043- 650	9000	....	VI	2.50- .687
22	Buda........6-DC-844	Lanova	T,Tr,B,I	AC	6-5¼x6	W	4	844	180-1800	150-1800	96-1200	13.00	725	75	29.8♦	460-1100	2850	....	VI	2.00- .540
23	Buda......6-DCM-844	Lanova	M	AC	6-5¼x6	W	4	844	180-1800	158-1800	112-1300	13.00	725	81	34.8	518-1100	....	3900	VI	2.00- .540
24	Caterpillar.....D-17000	Own	M,I,R	PC	8-5¾x8	W	4	1662	‡190-1000	180-1000	136-1000	.....	....	65	58.9♦	1042- 700	8000	7750	VI	....
25	Caterpillar.....D-13000	Own	Tr,M,R,I	PC	6-5¾x8	W	4	1246	‡150-1000	145-1000	115-1000	.....	....	73	48.8♦	842- 800	5610	5650	VI	....
26	Caterpillar......D-8800	Own	Tr,M,I	PC	4-5¾x8	W	4	831	‡102-1000	98-1000	79-1000	.....	....	75	55.7♦	561- 800	4400	4550	VI	....
27	Caterpillar......D-4600	Own	Tr.M,I	PC	6-4¼x5½	W	4	468	‡ 82-1600	78-1600	62-1600	.....	....	66	48.4♦	300-1100	3000	3130	VI	....
28	Caterpillar......D-4400	Own	Tr,M,I	PC	4-4¼x5½	W	4	312	‡ 55-1600	52-1600	41-1600	.....	....	65	58.5♦	194-1100	2400	2430	VI	....
29	Caterpillar......D-3400	Own	Tr,M,I	PC	4-3¾x5	W	4	221	‡ 34-1650	32.5-1650	25.2-1650	.....	....	54	75.0♦	127-1100	1890	1930	VI	....
30	Chrysler..........M12	....	M	....	6-3¾x5	....	...	331	....	....	....	14.75	....	....	......	....	....	....	VI	1.56- .375
31	Cooper-Bessemer(1)EN	....	M,R,I	DI	8-8x10½	W	4	4222	....	450- 900	400- 900	.....	800	83	40.0	3300- 600	....	16000	VI	3.12- .757
32	Cooper-Bessemer(1)GN	....	M,R,I	DI	8-10½x13½	W	4	9353	....	925- 750	750- 750	.....	750	85	48.0	7400- 450	....	36000	VI	4.00-1.125
33	Cummins............A	Own	T,B,Tr,M,R,I	DI	6-4x5	W	4	377	100-2200■	95-2200■	57-1800■	18.00	750	75	24.2	275-1200	1830	2030	VI	1.37- .406
34	Cummins............H	Own	T,B,Tr,M,R,I	DI	4-4⅞x6	W	4	448	100-1800■	83-1800	50-1200■	17.00	750	74	32.8	340- 800	1930	3315	VI	1.75- .500
35	Cummins............H	Own	T,B,Tr,M,R,I	DI	6-4⅞x6	W	4	672	150-1800■	125-1800	85-1400■	17.00	750	72	25.5	500- 800	2540	3670	VI	1.75- .500
36	Cummins........*HS	Own	T,B,Tr,M,R,I	DI	6-4⅞x6	W	4	672	200-1800■	175-1800	120-1400■	14.00	925	101	21.5	625-1400	3000	4040	VI	1.75- .500
37	Fairbanks-Morse (4) 36	Own	M,R,I	TC	6-4¼x6	W	4	510	....	75-1200	60-1200	16.80	800	78	......	335 1050	....	....	VI	....
38	Fairbanks-Morse (5) 36	Own	M,R,I	TC	6-5¼x7½	W	4	1068	....	150-1200	120-1200	14.70	800	74	......	660-1050	....	....	VI	....
39	Fairbanks-Morse (5) 46	Own	M,R,I	DI	6-8x10½	W	4	3167	....	324- 800	225- 720	14.90	800	78	......	2070- 650	....	....	VI	....
40	General Motors...2-71	Own	T,B,Tr,M,I,GS	DI	2-4¼x5	D	2	142	....	55-2000	30-1200	16.00	980	70	16.2♦	175-1000	890	....	VI	No Valves
41	General Motors...3-71	Own	T,B,Tr,M,I,GS	DI	3-4¼x5	D	2	212	....	83-2000	45-1200	16.00	980	70	13.9	263-1000	1150	....	VI	No Valves
42	General Motors...4-71	Own	T,B,Tr,M,I,GS	DI	4-4¼x5	D	2	284	....	110-2000	60-1200	16.00	980	70	11.8	350-1000	1300	....	VI	No Valves
43	General Motors...6-71	Own	T,B,Tr,M,I,GS	DI	6-4¼x5	D	2	425	....	165-2000	90-1200	16.00	980	70	10.1	525-1000	1600	....	VI	No Valves
44	Gray Marine........(7)	G.M.C.	M	DI	6-4¼x5	....	2	425	....	165-2000	120-1800	16.00	980	62	20.2	525-1000	....	2425	VI	No Valves
45	Guiberson......A-1020	Own	Aft.	DI	9-5⅛x5½	....	4	1021	310-2150	....	....	14.00	....	....	......	....	653	....	(17)	2.06- .437
46	Hercules........DIXD	Own	Tr,M,I,GS	TC	2-4¼x4½	D	4	127	27.6-1600	23.5-1600	23.5-1600	15.50	750	92	25.9	91-1300	610	610	VI	1.62- .375
47	Hercules.......DOOC	Own	T,Tr,M,I,GS	TC	4-4x4½	D	4	226	70-2600	60-2600	47-1800	14.50	750	91	15.9♦	162-1400	750	....	VI	1.62- .375
48	Hercules.......DOOD	Own	T,Tr,M,I,GS	TC	4-4¼x4½	D	4	255	79-2600	66-2600	53-1800	14.50	750	91	14.2♦	180-1400	750	....	VI	1.62- .375
49	Hercules....... DJXC	Own	T,B,Tr,M,R,I	TC	6-3¾x4½	D	4	298	83-2600	71-2600	59-1800	14.50	750	87	14.8♦	208 1500	875	....	VI	1.62- .375
50	Hercules.......DWXD	Own	T,B,Tr,M,R,I	TC	6-4¼x4¾	D	4	404	122-2400	104-2400	85-1800	14.50	750	93	14.4♦	299-1400	1220	....	VI	1.68- .395
51	Hercules........DRXB	Own	T,B,Tr,M,R,I	TC	6-4⅜x5¼	D	4	474	120-2000	102-2000	89-1600	14.50	750	94	16.1♦	350 1300	1435	....	VI	2.00- .395
52	Hercules........DRXC	Own	T,B,Tr,M,R,I	TC	6-4⅝x5¼	D	4	529	133-2000	113-2000	88-1400	14.50	750	94	16.3♦	380-1400	1435	....	VI	2.00- .395
53	Hercules........DFXD	Own	T,B,M,R,I,GS	TC	6-5½x6	D	4	855	193-1600	164-1600	147-1400	14.50	750	97	16.3♦	645-1350	2400	....	VI	2.37- .500
54	Hercules........DFXE	Own	T,B,Tr,M,R,I	TC	6-5⅝x6	D	4	895	200-1600	171-1600	153-1400	14.50	750	97	15.7♦	685-1200	2400	....	VI	2.37- .500
55	Hill...............2R	Own	M,I	PC	2-3½x5½	D	4	106	19-1500	17.3-1500	16.6-1500	16.00	....	85	64	69-1200	1225	1300	VI	1.37- .372
56	Hill...............4R	Own	M,I	PC	4-3½x5½	D	4	212	41-1500	36.3-1500	33-1500	16.00	....	85	44	142-1200	....	1750	VI	1.37- .372
57	Hill...............6R	Own	M,I	PC	6-3½x5½	D	4	317	63-1500	55-1500	50-1500	16.00	....	85	37.5	225-1200	....	2300	VI	1.37- .372
58	International......UD6	Own	Tr,I	PC	4-3⅞x5¼	D	4	248	45-1500	38-1500	31.2-1500	14.20	....	66	40.2♦	156- 800	1253	....	VI	1.50- .500
59	International......UD9	Own	Tr,I	PC	4-4.4x5½	D	4	334	63-1500	53-1500	42.4-1500	14.40	....	67	35.3♦	208- 800	1499	....	VI	1.65- .500
60	International.....UD14	Own	Tr,I	PC	4-4¾x6½	W	4	461	82-1350	66-1350	54.8-1350	13.67	....	70	32.3♦	300- 800	1771	....	VI	1.78- .503
61	International.....UD18	Own	Tr,I	PC	6-4¾x6½	W	4	691	119-1400	100-1400	80-1400	13.67	....	65	35.2♦	420- 800	2817	....	VI	1.78- .503
62	Kermath..........DIX	Hercules	M	TC	2-4x4½	D	4	113	....	27-1800	20-1800	15.50	750	78	43.5	81-1400	....	870	VI	1.62- .375
63	Kermath.........DOO	Hercules	M	TC	4-4x4½	D	4	226	....	65-2600	49-2600	14.50	500	66	24.5	162-1400	....	1200	VI	1.62- .375
64	Kermath..........DJX	Hercules	M	TC	6-3¾x4½	D	4	298	....	84-2600	63-2600	14.50	500	64	21.5	208-1500	....	1355	VI	1.62- .375
65	Kermath.........DRX	Hercules	M	TC	6-4⅜x5¼	D	4	474	....	113-1800	85-1800	14.50	475	79	24.7	350-1300	....	2100	VI	2.00- .395
66	Kermath.........DHX	Hercules	M	TC	6-5x6	D	4	707	....	160-1600	120-1600	14.50	475	84	26.5	530-1400	....	3182	VI	2.37- .500

ABBREVIATIONS

■—Without fan or muffler
♦—Based on automotive or industrial weight, all others on marine
‡—With full equipment but without radiator fan
*—Supercharged
**—Direct drive
†—Includes piston pin
††—From center line of crankshaft to top of engine
(1)—Also built in 6 cylinder models
(2)—Fan to flywheel housing
(3)—To top of water outlet (highest point)
(4)—Also built in 1, 2, 3, 4 and 8 cylinder models
(5)—Also built in 8 cylinder model
(6)—Air, electric
(7)—Also built in 1, 2, 3 and 4 cylinder models
(8)—Rating for marine work boats
(9)—With reduction gear
(10)—Cast iron to 1600 R.P.M., aluminum above 1600 R.P.M.
(11)—Includes radiator
(12)—From bottom of pan to air cleaner mounting flange
(13)—Automotive power ratings
(14)—Industrial power ratings
(16)—Overall engine length
(17)—15° off Vertically-in-head
A—Air
(a)—Aluminum on 1, 2 and 3 cyl.
AB—American Bosch
AC—Air chamber
AC—AC Spark Plug Co.
A-E—American Bosch or Ex-Cell-O Corp.
Aft—Aircraft
AI—Alloy iron
AL—Electric Auto-Lite Co.
Alu—Aluminum
AM—Air-Maze Corp.
AT—Arma Steel, tin plated
B—Buses
B-P—Bosh or Purolator
Brg—Briggs Clarifier Co.
Bur—Burgess
C—Cars
C—Closed
Car—Cartridge
Cof—Coffman
CI—Cast Iron
Com—Commercial Filters Corp.
CNM—Chrome-nickel molybdenum
Cun—Cuno Engineering Corp.
d—Dual

AND OTHER HEAVY OIL ENGINES

VALVES	PISTONS					PISTON PIN		CONNECTING RODS			MAIN BEARINGS		INJECTION SYSTEM									STARTING METHOD		OVER ALL DIMENSIONS			
Exhaust Port Diameter and Lift (In.)	Material	Length (In.)	Weight with Rings and Pin (Lb.)	No. of Compression Rings	No. of Oil Rings	Diameter and Length (In.)	Locked In—	Material (S.A.E. No.)	Center to Center Length (In.)	Weight with Cap and Bushing (Lb.)	Number	Diameter (In.)	Make of Pump	Make of Valve	Valve Type—Open or Closed	Orifices	Pressure—Nozzle Opening (Lb. per Sq. In.)	Air Cleaner—Make	Fuel Filter—Make	Lubricant Filter—Make	Minimum Recommended Cetane Number of Fuel	Make	Type	Length—Fan to Flywheel (In.)	Width (In.)	Height—To Top of Air Cleaner (In.)	Line Number
.96- .390	Alu	4.25	1.20	3	2	.937-2.75	F	X1335	7.56	2.50	2	2.25	AB	AB	C	Pi	1600	Op	AB	Op	45	Op	E-H	20 1/16	20 1/2	36 11/16	1
.96- .390	Alu	4.25	1.20	3	2	.937-2.75	F	X1335	7.56	2.50	4	2.25	AB	AB	C	Pi	1600	Op	AB	Op	45	Op	E-H	31 1/2	23 5/8	34 1/16	2
1.18- .486	Alu	4.93	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	5	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	33 27/32	25 3/4	36 1/4 (12)	3
1.18- .486	Alu	4.93	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	5	3.00	AB	AB	C	Pi	2000	....	B-P	DeL	46	DR	Ele	46 7/8 (11)	26 7/8	33 3/8 (12)	4
1.18- .486	Alu	4.93	3.36	3	2	1.25-3.06	F	1035	9.50	3.41	5	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	33 27/32	25 3/4	36 1/4 (12)	5
1.18- .486	Alu	5.06	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	7	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	42 15/32	27	35 19/32 (12)	6
1.18- .486	Alu	4.93	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	7	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	42 15/32	27	35 19/32 (12)	7
1.18- .486	Alu	4.93	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	7	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	42 15/32	27	35 19/32 (12)	8
1.18- .486	Alu	4.93	3.00	3	2	1.25-2.92	F	1035	9.50	3.41	7	3.00	AB	AB	C	Pi	2000	....	B-P	DeL	46	DR	Ele	54 3/16 (11)	27 11/32	34 9/16 (12)	9
1.31- .476	Alu	5.25	3.84	3	2	1.50-3.18	F	6140	11.00	4.87	7	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	48 1/2	25 3/4	37 5/16 (12)	10
1.37- .476	Alu	5.25	4.48	3	2	1.50-3.56	F	6140	11.00	4.87	7	3.00	AB	AB	C	Pi	2000	Uni	B-P	DeL	46	DR	Ele	48 1/2	25 3/4	37 5/16 (12)	11
1.37- .476	Alu	5.25	4.48	3	2	1.50-3.56	F	6140	11.00	4.87	7	3.00	AB	AB	C	Pi	2000	....	B-P	DeL	46	DR	Ele	61 17/32 (11)	29 7/8	36 7/8 (12)	12
1.56- .516	Alu	6.00	5.43	3	2	1.75-3.90	F	6140	12.50	10.25	7	3.50	AB	AB	C	Pi	2000	Uni	P-S	DeL	46	DR	Ele	57 3/4	34 5/16	44 15/16 (12)	13
1.56- .516	Alu	6.00	5.43	3	2	1.75-3.90	F	6140	12.50	10.25	7	3.50	AB	AB	C	Pi	2000	....	P-S	DeL	46	DR	Ele	76 1/16 (11)	32	43 1/2 (12)	14
1.78- .540	Alu	8.00	9.30	3	2	2.00-4.37	F	6140	14.25	13.10	7	3.50	AB	AB	C	Pi	2000	Uni	P-S	DeL	46	D-N	E-G	68 3/4	34 1/2	58 41/64 (12)	15
1.78- .540	Alu	8.00	9.30	3	2	2.00-4.37	F	6140	14.25	13.10	7	3.50	AB	AB	C	Pi	2000	....	P-S	DeL	46	D-N	E-G	88 1/16 (11)	32 13/16	47 3/4 (12)	16
2.02- .687	Alu	9.31	17.50	3	2	2.75-5.03	F	1035	17.75	28.51	7	3.75	AB	AB	C	Pi	1800	Uni	P-S	DeL	46	D-N	E-G	86 11/16	38 11/32	62 3/16 (12)	17
2.12- .687	Alu	9.31	17.50	3	2	2.75-5.28	F	1035	17.75	28.51	7	3.75	AB	AB	C	Pi	1800	Uni	P-S	DeL	46	D-N	E-G	86 11/16	38 11/32	62 3/16 (12)	18
2.16- .687	Alu	9.31	19.19	3	2	2.75-5.53	F	1035	17.75	28.51	7	3.75	AB	AB	C	Pi	1800	Uni	P-S	DeL	46	D-N	E-G	86 11/16	38 11/32	62 3/16 (12)	19
2.16- .687	Alu	9.31	19.19	3	2	2.75-5.53	F	1035	17.75	28.51	7	3.75	AB	AB	C	Pi	1800	....	P-S	DeL	46	D-N	E-G	114 7/8 (11)	37 3/16	62 7/16 (12)	20
2.16- .687	Alu	9.31	19.19	3	2	2.75-5.53	F	1035	17.75	28.51	7	3.75	AB	AB	C	Pi	1800	Uni	P-S	DeL	46	D-N	E-G	95 3/8	48	82 5/16 (12)	21
1.87- .540	Alu	6.75	6.70	3	2	1.75-4.50	F	1040	12.50	10.62	7	3.75	AB	AB	C	Pi	2000	Uni	Com	Com	46	L-D	E-G	58 1/8	29 5/16	48 1/4	22
1.87- .540	Alu	6.75	6.70	3	2	1.75-4.50	F	1040	12.50	10.62	7	3.75	AB	AB	C	Pi	2000	....	Com	Com	46	L-D	E-G	83 1/16	30 1/4	46 1/16	23
....	Alu	9.18	.....	4	2	2.37-4.75	F	....	16.00	.....	5	4.00	Own	Own	C	Si	1750	Don	Own	Own	35	Own	G	80 27/64	49 1/2	60 3/8	24
....	Alu	9.18	.....	3	1	2.37-4.75	F	....	15.00	.....	7	3.75	Own	Own	C	Si	1750	Don	Own	Own	35	Own	G	82 5/16	42 3/4	66 11/16	25
....	Alu	9.18	.....	3	1	2.37-4.75	F	....	15.00	.....	5	3.75	Own	Own	C	Si	1750	Don	Own	Own	35	Own	G	64 13/32	46 5/8	66	26
....	Alu	6.18	.....	3	2	1.75-3.50	F	....	10.25	.....	7	3.00	Own	Own	C	Si	1500	Don	Own	Own	35	Own	G	63 3/16	29 7/8	55 7/8	27
....	Alu	6.18	.....	3	2	1.75-3.50	F	....	10.25	.....	5	3.00	Own	Own	C	Si	1500	Don	Own	Own	35	Own	G	48 3/4	29 7/8	50 13/16	28
....	Alu	5.56	.....	3	2	1.56-3.00	F	....	10.25	.....	5	2.75	Own	Own	C	Si	1500	Don	Own	Own	35	Own	G	45 9/16	25	47 9/16	29
1.31- .375	Alu	5.46	3.25	3	1	1.12-3.25	...	1335	10.43	.....	7	3.00	.....	.....	...	...	.....	.....	.....	.....	.....	.....	.....	60 7/16	29 11/16	37 11/16	30
2.65- .757	Alu	14.00	28.75	4	2	3.25-7.00	R	3140	21.00	54.0†	9	6.00	Own	AB	C	Mu	2500	AM	Pur	Cun	....	Own	Air	128 1/2	30 1/2	66	31
3.75-1.125	Alu	17.17	58.00	5	2	4.00-9.37	R	1040	27.00	135.7†	9	7.50	Own	AB	C	Mu	2500	AM	Pur	Cun	....	Own	Air	158 1/2	42 1/4	83	32
1.37- .406	CI	5.04	5.70	3	2	1.49-3.37	F	E-4135	9.50	6.6	7	3.87	Own	Own	...	Mu	....	Don	Cun	Nug	50	L-D	Ele	46 3/8 (2)	28 3/8	39 1/16 (3)	33
1.75- .500	CI	6.25	10.56	3	2	1.99-4.09	F	E-4135	12.00	10.2	5	4.50	Own	Own	...	Mu	....	Don	Cun	Nug	50	L-D	Ele	43 7/32 (2)	29 5/8	47 11/32 (3)	34
1.75- .500	CI	6.25	10.56	3	2	1.99-4.09	F	E-4135	12.00	10.2	7	4.50	Own	Own	...	Mu	....	Don	Cun	Nug	50	L-D	Ele	57 3/32 (2)	29 5/8	47 11/32 (3)	35
1.75- .500	Alu	6.25	7.21	3	2	1.99-4.09	F	E-4135	12.00	10.2	7	4.50	Own	Own	...	Mu	....	Don	Cun	Nug	50	L-D	Ele	60 19/32 (2)	30 5/16	47 11/32 (3)	36
....	CI (a	.....	.....	...	...	....	...	....	.....	.....	7	3.00	AB	AB	C	Pi	1700	Op	.....	.....	50	.....	(6)(k)	65	25 3/4	32 7/8††	37
....	CI	.....	.....	...	...	....	...	....	.....	.....	8	5.50	AB	AB	C	Pi	1500	Op	.....	.....	50	.....	(6)	79 1/8	23 5/8	39 3/4††	38
....	CI	.....	.....	...	...	....	...	....	.....	.....	7	5.50	Own	Own	C	Mu	3000	Op	.....	.....	45	.....	Air	117	44 3/4	51††	39
1.25- .375	AT	6.00	7.53	4	2	1.50-3.62	F	1340	10.12	6.14	3	3.50	Own	Own	C	Mu	....	AC	AC	AC	45	DR	Ele	30 1/16	29 3/4	35 3/8	40
1.25- .375	AT	6.00	7.53	4	2	1.50-3.62	F	1340	10.12	6.14	4	3.50	Own	Own	C	Mu	....	AC	AC	AC	45	DR	Ele	36	30 5/8	38	41
1.25- .375	AT	6.00	7.53	4	2	1.50-3.62	F	1340	10.12	6.14	5	3.50	Own	Own	C	Mu	....	AC	AC	AC	45	DR	Ele	42	30 5/8	38	42
1.25- .375	AT	6.00	7.53	4	2	1.50-3.62	F	1340	10.12	6.14	7	3.50	Own	Own	C	Mu	....	AC	AC	AC	45	DR	Ele	54	30 5/8	38	43
1.25- .375	AT	6.00	7.00	4	2	1.50-3.62	F	T-1340	10.12	6.12	7	3.50	GM	GM	C	Mu	....	AC	AC	AC	40	DR	Ele	73 3/8	30 5/8	37 1/2	44
2.06- .437	Alu	5.12	6.29	3	2	1.37-4.62	F	6145	.....	.....	3	5.51	Own	AB	C	Pi	2500	N	AB	Cun	....	Cof	Car	37 3/8	37 1/8	47 1/8	45
1.12- .375	Alu	4.84	4.47	4	2	1.18-3.70	F	CNM	8.00	5.31	2	3.00	AB	AB	C	Pi	1450	.....	.....	.....	45	DR	E-H	27 11/16 (2)	16 5/8	36 1/4	46
1.12- .375	Alu	4.84	4.00	4	2	1.18-3.45	F	CNM	8.00	5.31	5	3.00	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	E-G	32 1/16 (2)	22 7/8	36	47
1.12- .375	Alu	4.84	4.47	4	2	1.18-3.70	F	CNM	8.00	5.31	5	3.00	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	E-G	32 1/16 (2)	22 7/8	36	48
1.12- .375	Alu	4.84	3.56	4	2	1.18-3.20	F	CNM	8.00	5.31	7	3.00	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	E-G	39 (2)	22 5/16	32 1/4	49
1.25- .395	Alu	4.84	4.47	4	2	1.18-3.70	F	CNM	8.50	.....	7	3.50	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	Ele	46 11/32 (2)	25 3/4	36 1/2	50
1.37- .395	Alu	6.84	7.09	4	2	1.62-3.75	F	CNM	9.37	8.59	7	3.50	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	E-G	46 5/16 (2)	27	38 3/4	51
1.37- .395	Alu	6.84	7.93	4	2	1.62-3.93	F	CNM	9.37	8.59	7	3.50	AB	AB	C	Pi	1650	.....	.....	.....	45	L-D	E-G	46 5/16 (2)	27	38 3/4	52
1.62- .500	Alu	7.53	12.37	4	2	2.00-4.65	F	CNM	12.00	13.75	7	4.50	AB	AB	C	Pi	2000	.....	.....	.....	45	L-D	Ele	62 21/32 (2)	30 5/8	46 5/16	53
1.62- .500	Alu	7.53	12.34	4	2	2.00-4.65	F	CNM	12.00	13.75	7	4.50	AB	AB	C	Pi	2000	.....	.....	.....	45	L-D	Ele	62 21/32 (2)	30 5/8	46 5/16	54
1.37- .372	Lyn	4.87	2.83	3	2	1.50-2.72	F	4140	13.25	7.3	3	2.93	AB	A-E	C	Pi	1800	Uni	Fram	Brg	....	AL	Ele	35	25	40	55
1.37- .372	Lyn	4.87	2.83	3	2	1.50-2.72	F	4140	13.25	7.3	5	2.93	AB	A-E	C	Pi	1800	Uni	Fram	Brg	....	AL	Ele	47 1/2	25	40	56
1.37- .372	Lyn	4.87	2.83	3	2	1.50-2.72	F	4140	13.25	7.3	7	2.93	AB	A-E	C	Pi	1800	AM	Fram	Brg	....	AL	Ele	58	27	45	57
1.31- .500	Alu	5.70	4.33	3	2	1.31-3.25	F	1040	10.00	8.01	5	3.75	Own	Own	C	Si	700	Don	Pur	Pur	....	Own	Ha	38 1/2	21 3/4	39 5/16	58
1.46- .500	Alu	6.43	6.22	3	2	1.50-3.70	F	1040	11.00	10.83	5	4.12	Own	Own	C	Si	700	Don	Pur	Pur	....	Own	Ha	41 1/2	23 13/16	42 1/2	59
1.53- .503	Alu	6.19	7.27	4	2	1.62-4.10	F	1040	13.25	11.91	5	3.25	Own	Own	C	Si	700	Don	Pur	Pur	....	Own	Ha	47 1/16	27 3/8	45 13/16	60
1.53- .503	Alu	6.19	7.27	4	2	1.62-4.10	F	1040	13.25	11.91	7	3.50	Own	Own	C	Si	700	Don	Pur	Pur	....	Own	Ha	60 11/16	29 1/4	47 5/16	61
1.12- .375	Alu	4.84	4.00	5	1	....	..	CNM	8.00	5.31	2	....	AB	AB	C	Pi	1650	AC	Pur	DeL	....	DR	Ele	41 9/16	23	30 3/8	62
1.12- .375	Alu	4.84	4.00	5	1	....	..	CNM	8.00	5.31	...	....	AB	AB	C	Pi	1650	AC	Pur	Pur	....	DR	Ele	47 3/4	22 1/2	33	63
1.12- .375	Alu	4.84	3.56	5	1	....	..	CNM	8.00	5.31	...	....	AB	AB	C	Pi	1650	AC	Pur	Pur	....	DR	Ele	54 11/16	22 1/2	33	64
1.37- .395	Alu	6.84	7.09	5	1	....	..	CNM	9.37	8.59	...	....	AB	AB	C	Pi	1650	AM	Pur	Pur	....	DR	Ele	60 1/16	27 5/8	37 13/16	65
1.62- .500	Alu	7.53	9.94	5	1	....	..	CNM	12.00	13.00	...	....	AB	AB	C	Pi	1650	AM	Pur	Pur	....	DR	Ele	76 5/8	31	45	66

D—Dry liners used
DeL—DeLuxe Products Corp.
DI—Direct injection
D-N—Delco-Remy or Novo
Don—Donaldson Co.
DR—Delco-Remy Div.
E-G—Electric or auxiliary gasoline engine
E-H—Electric or hand
Ele—Electric
Exc—Ex-Cell-O Corp.
F—Floating
G—Auxiliary gasoline engine, electric optional
GI—Grey Iron Casting
G. M. Corp—General Motors Corp.
GS—Generating sets
H—Heat Exchanger, marine only
Ha—Hand
HC—Honan-Crane Corp.
Hes—Hesselman
HI—Horizontally In-head
I—Industrial
(k)—Hand start optional on 1, 2 and 3 cyl.
L-D—Leece Neville or Delco-Remy
LE—Lanova energy cell
LN—Leece Neville Co.
Lyn—Lynite
M—Marine
Mic—Michiana Products Corp.
Mu—Multiple
N—No or none
Nug—Nugent
O—Open
OP—Oilpure Refiner Co.
P—Piston
PC—Precombustion chamber
Pi—Pintle
P-S—Purolator or Stewart-Warner
Pur—Purolator Products, Inc.
R—Railcars
R—Locked in Rod
Si—Single
Ss—Semi-steel (electric furnace)
T—Trucks
TC—Turbulence chamber
Tr—Tractors
Uni—United Air Cleaner Div.
VI—Vertically In-head
Vik—Viking
Vor—Vortex
W—Wet liners used
Wau-Hes—Waukesha-Hesselman
WGB—WGB Oil Clarifier, Inc.

Automotive Diesel and

Line Number	ENGINE MAKE AND MODEL	Built Under License from	GENERAL: Designed for	Type	Number of Cylinders Bore and Stroke (In.)	Cylinder Liners—Type	Cycle	Piston Displacement (Cu. In.)	With Bare Engine: Maximum Brake Hp. at Specified R.P.M.	With Standard Accessories: Max. Intermittant Hp. at Specified R.P.M.	With Standard Accessories: Continuous Sustained Hp. at Specified R.P.M.	Compression Ratio - to 1	Max. Combustion Pressure (Lb. per Sq. In.)	B.M.E.P. at Continuous Hp. (Lb. per Sq. In.)	Weight per Continuous Hp. (Lb.)	Max. Torque in Lb. Ft. at Specified R.P.M.	Shipping Weight (Lb.): Automotive or Industrial	Shipping Weight (Lb.): Marine	VALVES: Arrangement	VALVES: Intake Port Diameter and Lift (In.)
1	Mack END457	Lanova	T,B	LE	6-4¼x5⅜	D	4	457	...	...	...	14.60	840	...	...	355-1100	...	...	VI	1.56- .418
2	Mack END605	Lanova	T,B	LE	6-4⅝x6	D	4	605	144-2000	130-2000	...	14.63	840	...	...	455-1100	1980	...	VI	1.64- .500
3	Mack Mar..... 457D-W	Lanova	M	LE	6-4¼x5⅜	D	4	457	110-1800	...	70-1500(8)	14.60	840	90	32.5	355-1100	...	2275(9)	VI	1.56- .418
4	Mack Mar..... 457D-Y	Lanova	M	LE	6-4¼x5⅜	D	4	457	115-1950	...	...	14.60	840	...	...	355-1100	...	2250**	VI	1.56- .418
5	Mack Mar..... 605D-W	Lanova	M	LE	6-4⅝x6	D	4	605	125-1800	...	100-1500(8)	14.63	840	90	32.0	410-1000	...	3200(9,	VI	1.64- .500
6	Mack Mar.... 605D-Y	Lanova	M	LE	6-4⅝x6	D	4	605	140-1800	133-1800	...	14.63	840	...	...	455-1100	...	2775	VI	1.64- .500
7	Murphy ME-4	Own	M,I,GS	DI	4-5¾x6½	W	4	675	...	105-1200	90-1200	17.00	...	88	47.0	472- 900	4300	6350	VI	1.62d-.500
8	Murphy ME-6	Own	M,I,GS	DI	6-5¾x6½	W	4	1013	...	160-1200	135-1200	17.00	...	88.5	38.5	732- 850	5200	7940	VI	1.62d-.500
9	Murphy *ME-650	Own	M,I,GS	DI	6-5¾x6½	W	4	1013	...	200-1200	165-1200	14.00	...	107	37.0	960- 775	5900	8190	VI	1.62d-.500
10	Murphy ME-66	Own	M,I,GS	DI	6-6x6½	W	4	1103	...	180-1200	150-1200	17.00	...	90	34.5	8.30-800	5200	7940	VI	1.62d-.500
11	Murphy ME-46	Own	M,I,GS	DI	4-6x6½	W	4	735	...	115-1200	100-1200	17.00	...	90	43.0	5.53-800	4300	6350	VI	1.62d-.500
12	Red Wing 42-54HP	Wau-Hes	M	DI	4-4x5	W	4	251	55-2200	54-2000	43-1500	5.90	500	65	25.6	155-1000	...	1100	VI	1.62- .445
13	Red Wing 55-60HP	Wau-Hes	M	DI	4-4⅝x5¼	W	4	353	62-1600	59-1600	55-1400	5.60	500	88	21.8	230- 800	...	1200	VI	1.75- .455
14	Red Wing 65-75HP	Wau-Hes	M	DI	6-3¾x4¼	W	4	282	78-2800	75-2800	59-1800	6.40	500	92	22.0	174-1400	...	1300	VI	1.62- .371
15	Red Wing .. 100-125HP	Wau-Hes	M	DI	6-4½x5½	W	4	525	128-2100	125-2100	106-1500	5.80	500	107	17.0	370-1500	...	1800	VI	1.87- .530
16	Red Wing .. 160-180HP	Wau Hes	M	DI	6-6½x7	W	4	1395	174-1125	170-1125	165-1050	5.40	500	89	33.9	900-500	...	5600	VI	2.50- .710
17	Red Wing .. 180-200HP	Wau-Hes	M	DI	6-7x7	W	4	1616	200-1125	196-1125	188-1050	5.30	500	87	30.8	1030-500	...	5800	VI	2.50- .710
18	Scripps 7000A,1A,2A,3A	Hercules	M	TC	4-4¼x4½	D	4	255	79-2600	68-2600	52-1800	14.50	750	90	23.1	185-1400	...	1200	VI	1.62- .375
19	Scripps 8500A,1A,2A,3A	Hercules	M	TC	6-4x4½	D	4	339	103-2600	88-2600	68-1800	14.50	750	88	21.1	238-1500	...	1435	VI	1.62- .375
20	Superior A-4	Own	M.I	TC	4-4½x5¾	W	4	366	...	62.5-1500	42-1200	11.80	675	76	44.6	268-1200	...	1875	VI	1.87- .432
21	Superior A-6	Own	M,I	TC	6-4½x5¾	W	4	549	...	110-1800	62.5-1200	11.80	675	75	38.4	400-1200	...	2400	VI	1.87- .432
22	Superior D-4	Own	M,I	TC	4-5½x7	W	4	665	...	90-1200	76-1200	11.80	750	75	36.0	328-1200	...	3500	VI	2.25- .652
23	Superior D-6	Own	M,I	TC	6-5½x7	W	4	998	...	170-1500	114-1200	11.80	750	76	27.3	727-1000	...	4250	VI	2.25- .652
24	Superior D-8	Own	M,I	TC	8-5½x7	W	4	1330	...	230-1500	152-1200	11.80	750	75	34.9	985-1000	...	5300	VI	2.25- .652
25	Superior .... P.T.D.	Own	M,I	DI	6-8½x10½	W	4	3575	...	300- 900	240- 720	12.50	750	74	54.2	1750- 900	...	13000	VI	3.12- .875
26	Superior .... P.T.D.	Own	M,I	DI	8-8½x10½	W	4	4767	...	400- 900	320- 720	12.50	750	74	50.0	2000- 900	...	16000	VI	3.12- .875
27	Waukesha .. (14) 130HS	Hes	T,Tr,I	DI	4-3¾x5	W	4	221	48-2200	38-2200	28-1500	6.12	500	67	24.8♠	142-1000	695	...	VI	1.62- .445
28	Waukesha .. (14) 130HL	Hes	T,Tr,I	DI	4-4x5	W	4	251	55-2200	44-2200	31-1500	5.90	500	65	22.7	155-1000	705	...	VI	1.62- .445
29	Waukesha .. (14) VRZH	Hes	T,Tr,I	DI	4-4⅝x5¼	W	4	353	59-1600	47-1600	41-1400	5.60	500	65	25.6♠	229-700	1050	...	VI	1.75- .450
30	Waukesha .. (13) 6BKH	Hes	T,B,I	DI	6-3¾x4¼	N	4	282	83-2800	67-2800	44-1800	6.40	500	69	22.1♠	174-1400	975	...	VI	1.62- .375
31	Waukesha .. (13) 140HS	Hes	T,B,I	DI	6-4¼x5½	W	4	468	114-2250	95-2250	67-1500	5.80	500	75	22.5♠	342-1000	1510	...	VI	1.87- .531
32	Waukesha . (13) 140HK	Hes	T,B,I	DI	6-4½x5½	W	4	525	128-2250	109-2250	75-1500	5.80	500	74	21.0♠	383-1000	1550	...	VI	1.87- .531
33	Waukesha . (13) 145HK	Hes	T,B,M,I	DI	6-5¼x6	W	4	779	174-2000	148-2000	106-1400	5.60	500	77	17.6♠	550-900	1865	2900	VI	1.87- .594
34	Waukesha (14) 6WALH	Hes	T,B,M,I	DI	6-5¾x6½	W	4	1013	172-1800	135-1600	117-1300	5.25	500	70	26.9♠	686-700	3150	3885	VI	2.37- .656
35	Waukesha (14) 6WAKH	Hes	T,B,M,R,I	DI	6-6¼x6½	W	4	1197	202-1800	162-1600	139-1300	5.20	500	71	23.0♠	811-700	3200	3935	VI	2.37- .656
36	Waukesha .. (14) 6EKH	Hes	I	DI	6-7x7	W	4	1616	196-1125	154-1125	142-1050	5.50	500	67	42.2♠	1030-500	6000	...	VI	2.50- .713
37	Waukesha .. (14) 6NKH	Hes	M,I	DI	6-7x8½	W	4	1962	226-1050	187-1050	160-950	5.42	500	68	38.8♠	1350-650	6200	7280	VI	2.50- .713
38	Waukesha .. (14) 6LRH	Hes	M,R,I	DI	6-8½x8½	W	4	2894	333-1050	277-1050	225-900	5.43	500	68	47.8♠	1830-550	10750	9350	VI	3.25- .750

ABBREVIATIONS

■—Without fan or muffler
♠—Based on automotive or industrial weight all others on marine
‡—With full equipment but without radiator fan
*—Supercharged
**—Direct drive
†—Includes piston pin
††—From center line of crankshaft to top of engine
(1)—Also built in 6 cylinder models
(2)—Fan to flywheel housing
(3)—To top of water outlet (highest point)
(4)—Also built in 1, 2, 3, 4 and 8 cylinder models
(5)—Also built in 8 cylinder model
(6)—Air, electric
(7)—Also built in 1, 2, 3 and 4 cylinder models
(8)—Rating for marine work boats
(9)—With reduction gear
(10)—Cast iron to 1600 R.P.M., aluminum above 1600 R.P.M.
(11)—Includes radiator
(12)—From bottom of pan to air cleaner mounting flange
(13)—Automotive power ratings
(14)—Industrial power ratings
(16)—Overall engine length
(17)—15° off Vertically-in-head
A—Air
(a)—Aluminum on 1, 2 and 3 cyl.
AB—American Bosch
AC—Air chamber
AC—AC Spark Plug Co.
A-E—American Bosch or Ex-Cell-O Corp.
Aft—Aircraft
Al—Alloy iron
AL—Electric Auto-Lite Co.
Alu—Aluminum
AM—Air-Maze Corp.
AT—Arma Steel, tin plated
B—Buses
B-P—Bosh or Purolator
Brg—Briggs Clarifier Co.
Bur—Burgess
C—Cars
C—Closed
Car—Cartridge
Cof—Coffman
CI—Cast Iron
Com—Commercial Filters Corp.
CNM—Chrome-nickel molybdenum
Cun—Cuno Engineering Corp.
d—Dual

Graduates of the AAF Training Command

(Courses Successfully Completed)

AIR CREW MEMBERS TRAINED

	1939	1940	1941	1942	11 Months 1943	Total 1939-1943
Pilots	696	1,786	7,244	28,782	56,008	94,516
Navigators	....	44	601	4,477	13,783	18,905
Bombardiers	....	18	310	5,760	13,998	20,086
Aerial Gunners	....	....	....	25,820	81,398	107,218
Miscellaneous	....	....	198	2,325	18,850	21,373
Total	696	1,843	8,353	67,164	184,037	262,098

TECHNICIANS TRAINED

	1942	11 Months 1943	Total 1939-1943
Graduates of Officer's Courses	28,374	35,856	64,230
Graduates of Factory Courses	40,448	73,634	114,082
Graduates of Advanced Courses	10,194	42,004	52,198
Graduates of Basic Courses			
Airplane Mechanics	99,829	140,531	240,360
Radio Operator—Mechanics	32,763	67,576	100,339
Armorers	21,302	48,864	70,166
Clerks	9,017	37,035	46,052
Miscellaneous	31,141	67,833	98,974
Total—All Technicians	273,068	513,333	786,041

Other Heavy Oil Engines—*Concluded*

Valves: Exhaust Port Diameter and Lift (In.)	Pistons: Material	Pistons: Length (In.)	Pistons: Weight with Rings and Pin (Lb.)	Pistons: No. of Compression Rings	Pistons: No. of Oil Rings	Piston Pins: Diameter and Length (In.)	Piston Pins: Locked in—	Connecting Rods: Material (S.A.E. No.)	Connecting Rods: Center to Center Length (In.)	Connecting Rods: Weight with Cap and Bushing (Lb.)	Main Bearings: Number	Main Bearings: Diameter (In.)	Injection System: Make of Pump	Injection System: Make of Valve	Injection System: Valve Type—Open or Closed	Injection System: Orifices	Injection System: Pressure—Nozzle Opening (Lb per Sq. In.)	Air Cleaner—Make	Fuel Filter—Make	Lubricant Filter—Make	Minimum Recommended Cetane Number of Fuel	Starting Method: Make	Starting Method: Type	Over All Dimensions: Length—Fan to Flywheel (In.)	Over All Dimensions: Width (In.)	Over All Dimensions: Height—To Top of Air Cleaner (In.)	Line Number
1.56- .418	Alu	5.29	.....	3	2	1.43-3.81	F	4130	10.50	......	7	3.50	AB	AB	C	Pi	1400	Vor	Pur	DeL	46	LN	Ele	27 7/8	46	50 15/16	1
1.64- .500	Alu	5.62	6.30	3	2	1.62-4.17	F	4130	11.25	7.13	7	3.50	AB	AB	C	Pi	1700	Vor	Pur	Own	46	LN	Ele	53 3/32	31 7/8	53 3/32	2
1.56- .418	Alu	5.29	.....	3	2	1.43-3.81	F	4130	10.50	......	7	3.50	AB	AB	C	Pi	1400	WGB	Pur	WGB	46	LN	Ele	71 3/8(16)	27	39 1/2	3
1.56- .418	Alu	5.29	.....	3	2	1.43-3.81	F	4130	10.50	......	7	3.50	AB	AB	C	Pi	1400	WGB	Pur	WGB	46	LN	Ele	71 3/8(16)	27	39 1/2	4
1.64- .500	Alu	5.62	6.30	3	2	1.62-4.17	F	4130	11.25	7.13	7	3.50	AB	AB	C	Pi	1700	WGB	Pur	WGB	46	LN	Ele	80 3/8(16)	29	41 3/16	5
1.64- .500	Alu	5.62	6.30	3	2	1.62-4.17	F	4130	11.25	7.13	7	3.50	AB	AB	C	Pi	1700	WGB	Pur	WGB	46	LN	Ele	80 3/8(16)	29	41 3/16	6
1.62d-.500	GI	7.75	19.43	4	2	2.12-4.73	F	1035	12.50	14.7	5	4.00	Own	Own	C	Mu	1500	Don	OP	Pur	50	DR	Ele	56 7/16	37	60 15/16	7
1.62d-.500	GI	7.75	19.43	4	2	2.12-4.73	F	1035	12.50	14.7	7	4.00	Own	Own	C	Mu	1500	Don	OP	Pur	50	DR	Ele	73 7/16	37	53 3/4	8
1.62d-.500	GI	7.75	20.5	4	2	2.12-4.73	F	1035	12.50	14.7	7	4.00	Own	Own	C	Mu	1500	Don	OP	Pur	50	DR	Ele	76 3/16	37	51 15/16	9
1.62d-.500	GI	7.75	20.9	4	2	2.12-4.98	F	1035	12.50	14.7	7	4.00	Own	Own	C	Mu	1500	Don	OP	Pur	50	DR	Ele	76 7/16	37	57 1/8	10
1.62d-.500	GI	7.75	20.9	4	2	2.12-4.98	F	1035	12.50	14.7	5	4.00	Own	Own	C	Mu	1500	Don	OP	Pur	50	DR	Ele	56 7/16	37	60 15/16	11
1.25- .453	CI	5.12	4.30	3	1	1.12-3.06	F	1045	8.75	3.56	3	2.62	AB	Hes	O	Mu	1200	.....	Mic	Mic	....	DR	Ele	48 5/16	24	33 9/16	12
1.50- .450	CI	5.96	6.00	3	1	1.31-....	F	1045	10.50	5.30	3	2.37	AB	Vik	O	Mu	1200	.....	Mic	Mic	60	AL	Ele	52 13/16	21 1/4	38 1/8	13
1.25- .375	Alu	4.87	2.56	3	1	1.00-3.50	F	1045	8.00	3.50	7	2.62	AB	Vik	O	Mu	1200	.....	Mic	Mic	60	DR	Ele	53 13/16	23 1/8	31 1/8	14
1.37- .469	Alu	6.50	4.00	3	1	1.37-3.87	F	1045	10.25	5.31	7	3.25	AB	Vik	O	Mu	1200	.....	Mic	Mic	60	DR	Ele	78 3/8	29	41 5/16	15
2.25- .710	CI	9.25	20.50	3	1	2.00-5.50	F	1045	15.37	19.60	7	3.75	AB	Vik	O	Mu	1200	Vor	Mic	DeL	60	DR	Ele	100 11/16	30 1/2	56 15/16	16
2.25- .710	CI	9.25	24.75	3	1	2.00-6.00	F	1045	15.37	19.60	7	3.75	AB	Vik	O	Mu	1200	Vor	Mic	DeL	60	DR	Ele	100 11/16	30 1/2	56 15/16	17
1.12- .375	Alu	4.84	4.00	4	2	1.18-3.45	F	CNM	8.00	5.31	5	3.00	AB	AB	C	Pi	1650	AC	Pur	Pur	45	DR	Ele	46 5/8	24 1/4	22 3/4	18
1.12- .375	Alu	4.84	3.56	4	2	1.18-3.20	F	CNM	8.00	5.31	7	3.00	AB	AB	C	Pi	1650	AC	Pur	Pur	45	DR	Ele	53 9/16	24 1/4	22 3/4	19
1.50- .483	CI	6.68	9.25	4	2	1.75-3.59	F	1040	11.50	8.75	5	3.50	AB	AB	C	Pi	1600	Bur	Pur	Pur	50	LN	Ele	....	....	....	20
1.50- .483	(10)	6.68	9.25	4	2	1.75-3.59	F	1040	11.50	8.75	7	3.50	AB	AB	C	Pi	1600	Bur	Pur	Pur	50	LN	Ele	....	....	....	21
1.87- .605	Alu	8.00	6.50	3	2	2.12-4.50	F	1040	14.25	18.00	5	4.50	AB	AB	C	Pi	1600	Bur	Pur	Pur	50	LN	Ele	....	....	....	22
1.87- .605	Alu	8.00	6.50	3	2	2.12-4.50	F	1040	14.25	18.00	7	4.50	AB	AB	C	Pi	1600	Bur	Pur	Pur	50	LN	Ele	....	....	....	23
1.87- .605	Alu	8.00	6.50	3	2	2.12-4.50	F	1040	14.25	18.00	9	4.50	AB	AB	C	Pi	1600	Bur	Pur	Pur	50	LN	Ele	....	....	....	24
3.12- .875	CI	13.78	73.50	4	2	3.53-7.00	F	1045	21.00	75.50	7	6.00	AB	AB	C	Mu	3000	Bur	Bur	Pur	45	.....	Air	....	....	....	25
3.12- .875	CI	13.78	73.50	4	2	3.53-7.00	F	1045	21.00	75.50	9	6.00	AB	AB	C	Mu	3000	Bur	Bur	Pur	45	.....	Air	....	....	....	26
1.25- .453	CI	5.12	3.60	3	1	1.12-3.06	F	1045	8.75	3.56	3	2.62	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	E-H	33 9/16	21 1/2	38 3/4	27
1.25- .453	CI	5.12	4.30	3	1	1.12-3.06	F	1045	8.75	3.56	3	2.62	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	E-H	33 9/16	21 1/2	38 3/4	28
1.50- .450	CI	5.96	6.00	3	1	1.31-4.06	F	1045	10.50	5.31	3	2.37	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	E-H	39 9/16	25 3/4	34 7/16	29
1.25- .375	Alu	4.87	2.56	3	1	1.00-3.50	F	1045	8.00	3.50	7	2.62	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	E-H	39 1/2	25 3/4	34 3/8	30
1.37- .469	Alu	6.50	3.75	3	1	1.37-3.62	F	1045	10.25	5.31	7	3.25	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	Ele	50 3/8	21 13/16	41 13/16	31
1.37- .469	Alu	6.50	4.00	3	1	1.37-3.87	F	1045	10.25	5.31	7	3.25	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	Ele	50 3/8	21 13/16	41 13/16	32
1.37- .531	Alu	7.25	6.44	3	1	1.62-4.87	F	1045	11.75	8.31	7	3.50	AB	Hes	O	Mu	750	Op	Mic	Mic	....	Op	Ele	55 13/16	25 3/4	46 3/8	33
2.00- .656	CI	8.37	16.40	3	1	1.87-5.00	F	1045	13.25	12.20	7	4.00	AB	Hes	O	Mu	780	Op	Mic	Mic	....	Op	E-G	65 5/8	30 5/8	50 7/8	34
2.00- .656	CI	8.37	11.00	3	1	1.87-5.50	F	1045	13.25	12.20	7	4.00	AB	Hes	O	Mu	780	Op	Mic	Mic	....	Op	E-G	65 5/8	30 5/8	50 7/8	35
2.25- .710	CI	9.25	24.75	3	1	2.00-6.00	F	1045	15.37	19.60	7	3.75	AB	Hes	O	Mu	780	Op	Mic	Mic	....	Op	E-G	76	32 3/8	57 5/16	36
2.25- .710	CI	9.25	24.75	3	1	2.00-6.00	F	1045	15.37	19.60	7	3.75	AB	Hes	O	Mu	780	Op	Mic	HC	....	Op	E-G	76	32 3/8	57 5/16	37
2.75- .840	CI	11.65	50.00	4	1	2.25-7.75	F	1045	20.87	34.70	7	4.25	AB	Hes	O	Mu	1000	Op	Mic	Mic	....	Op	E-G	95 1/8	46 1/2	65 1/16	38

D—Dry liners used
DeL—DeLuxe Products Corp.
DI—Direct injection
D-N—Delco-Remy or Novo
Don—Donaldson Co.
DR—Delco-Remy Div.
E-G—Electric or auxiliary gasoline engine
E-H—Electric or hand
Ele—Electric
Exc—Ex-Cell-O Corp.
F—Floating
G—Auxiliary gasoline engine, electric optional
GI—Grey Iron Casting
G. M. Corp—General Motors Corp.
GS—Generating sets
H—Heat Exchanger, marine only
Ha—Hand
HC—Honan-Crane Corp.
Hes—Hesselman
HI—Horizontally In-head
I—Industrial
(k)—Hand start optional on 1, 2 and 3 cyl.
L-D—Leece Neville or Delco-Remy
LE—Lanova energy cell
LN—Leece Neville Co.
Lyn—Lynite
M—Marine
Mic—Michiana Products Corp.
Mu—Multiple
N—No or none
Nug—Nugent
O—Open
OP—Oilpure Refiner Co.
P—Piston
PC—Precombustion chamber
Pi—Pintle
P-S—Purolator or Stewart-Warner
Pur—Purolator Products, Inc.
R—Railcars
R—Locked in Rod
Si—Single
Ss—Semi-steel (electric furnace)
T—Trucks
TC—Turbulence chamber
Tr—Tractors
Uni—United Air Cleaner Div.
VI—Vertically In-head
Vik—Viking
Vor—Vortex
W—Wet liners used
Wau-Hes—Waukesha-Hesselman
WGB—WGB Oil Clarifier, Inc.

U. S. Aircraft Final Assembly Plants in Operation*

(Military Production Only)

	Engines: Number of Plants †	Engines: Number of Employees ‡	Propellers: Number of Plants †	Propellers: Number of Employees ‡	Airframes: Number of Plants †	Airframes: Number of Employees ‡
1938	4	7,000	2	1,000	9	24,000
1939	7	8,000	4	1,500	17	28,000
1940	12	25,000	4	4,000	25	86,000
1941	16	59,000	9	10,000	38	199,000
1942	22	157,000	13	25,000	51	471,000
1943	22	271,000	19	48,000	67	864,000

*—From report of Commanding General of the Army Air Forces.
†—Includes Canadian plants engaged in U. S. financed activities.
‡—Excludes employees in Canadian plants engaged in U. S. financed activities; mid-year data.

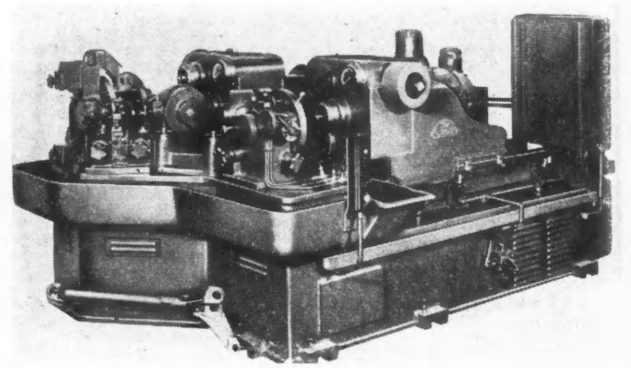
New Production Equipment

A SPECIAL machine has been designed and built by Snyder Tool and Engineering Company, Detroit, Mich., for core drilling, redrilling and reaming holes through very tough steel. The machine is equipped with two hydraulically operated slides, one carrying a single spindle and the other a three-spindle head.

Tool spindles are equipped with breech locks enabling the operator to exchange tools readily. Each side of the machine has its own push button station and is an independent mechanism. Because various high speed steel and tungsten carbide tools are used, a wide variation in spindle speed is provided through A.C.-D.C. motors with rheostat control. Spindle speeds are indicated on speedometer dials on the heads.

Varying feed rates for different tools are provided by means of two metering valves set for predetermined feed rate, the rate desired being secured by setting a hand valve on the side of the machine. This valve is conveniently placed so that the operator when changing tools can set the desired feed rate and also set the rheostat controlling spindle speed.

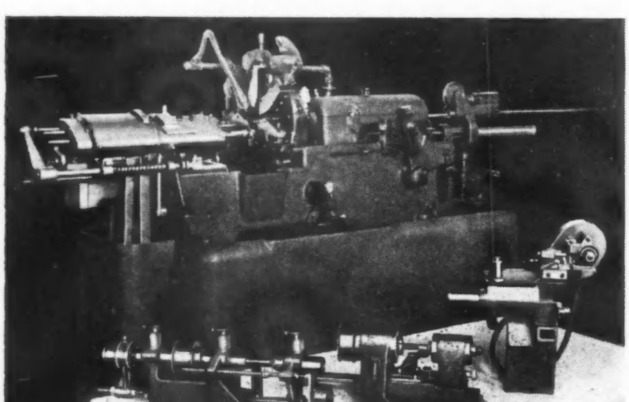
The fixture locates and supports the part for the drilling operation and is designed to accommodate both right and left hand parts. And because right and left hand parts are processed, the second unit is equipped with three spindles. The fixture sub-assemblies are mounted upon a sub-base which is also a chip trough.



Snyder machine for core drilling, re-drilling and reaming

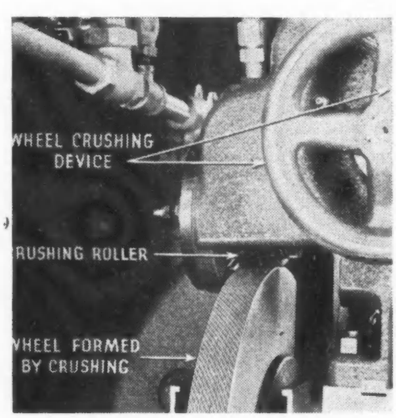
A NEW set of attachments which increases the range of work that can be handled on the Wickman No. 2 Swiss type automatic is announced by The Wickman Corporation, Detroit, Mich. There are five attachments in the group: a three-spindle attachment for multiple operations and separate attachments for high speed drilling, threading, slotting and taper pin turning.

The Wickman three-spindle attachment, shown mounted on the machine, may be used for centering, drilling, reaming, threading or tapping. The high speed drilling attachment, center, is used for drilling and centering operations. The Wickman threading attachment, at the left of the illustration, performs precision threading operations with self-opening die heads. The slotting attachment, shown at the extreme right of the picture, is used to slot or mill the end of any part produced on the Wickman No. 2 Automatic. Although tapers can be generated by regular methods on the machine, an attachment is provided for making long, accurate tapers. This attachment transfers the taper from a ground form bar directly to the No. 1 tool.



Wickman No. 2 Swiss type automatic and attachments

THE Sheffield Corporation, Dayton, Ohio, has developed a thread grinder which employs a crusher roll instead of a diamond for dressing the multi-ribbed grinding wheel. The crusher roll method of dressing wheels employs a hardened steel roller which has been accurately ground with a series of annular grooves of correct thread form or ground to a special form. It is en-



Multi-ribbed wheel and crushing roller of Sheffield thread grinder.

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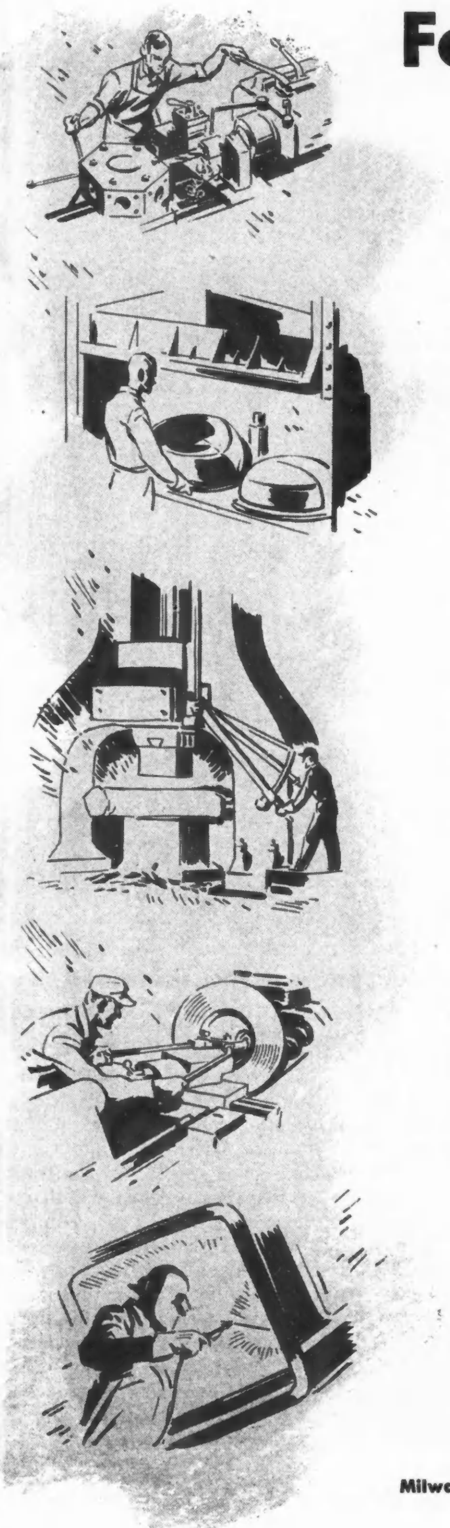
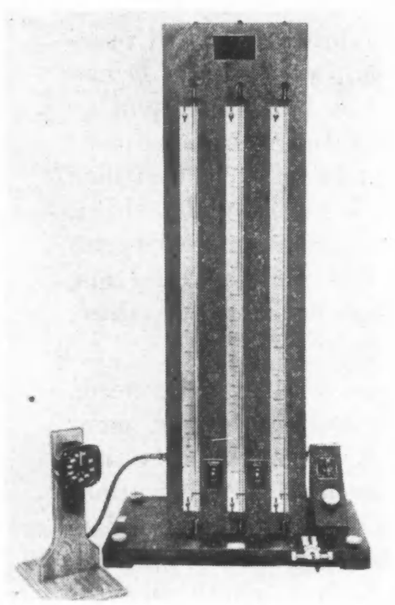


New Products for Aircraft

Precision Monometer for Testing Instruments

A precision manometer Type CTE-503, for use in testing and calibrating sensitive pressure instruments has recently been developed by Kollsman Instrument Division of Square D Company, Elmhurst, N. Y. The new manometer uses three liquids of varying



Kollsman precision manometer

densities to obtain accuracy over a wide range of pressure and still keep the meniscus within the eyelevel of the operator.

Designed as a standard for calibrating aircraft airspeed indicators, pressure gages and differential pressure gages, the manometer is also suitable for use in many aircraft and industrial test applications. Scales can be provided to read in miles per hour, knots, kilometers per hour, inches of water, inches of mercury or any other standard unit.

Each column is provided with an overflow well at the top of the column with a capacity 50 per cent greater than the entire system. If the operator inadvertently applies too much pressure to a column, the liquid is forced into the safety well and the air bubbles past. As soon as the pressure is released, all the liquid automatically drops back into the system.

Each scale is provided with an adjustable zero setting handle. A specially designed needle valve permits very close adjustment and, in addition to this, a rubber tube passing through a set of rollers is employed for vernier adjustment.

New Type Landing Mechanism for Planes

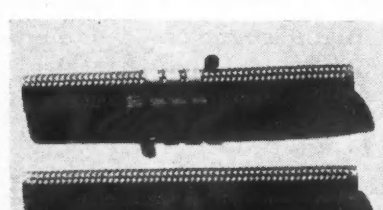
A new type landing mechanism for airplanes, called an air-spring strut, is a recent development of The Firestone Tire & Rubber Co., Akron, Ohio.

The air in the new landing mechanism is confined in a flexible rubberized container which operates much like an accordian bellows. With the air-spring, all the shock-absorbing properties of a pneumatic tire are repeated in the landing strut.

To absorb the tremendous energy of an airplane's first impact in landing, oil heretofore has been generally used. The oil is confined and forced through a small hole at high pressure. The Firestone airspring uses an identical principle, except that a large volume of air at low pressure is used instead of oil.

Ignition Conduit and Clip Sizing Sleeve

Aerocon, a new ignition conduit, is now being manufactured by Titeflex, Inc., of Newark, N. J. Its construction is said to give this conduit such vibration characteristics that it does not harmonize with the normal range of aircraft engine vibrations. In addition, Aerocon has unusual electrical shielding qualities.



Aerocon ignition conduit and flexible clip sizing sleeve made by Titeflex, Inc.

Another new development by Titeflex, Inc., is a flexible clip sizing sleeve for use on ignition conduit. Heat-treated to a spring temper, this sizing sleeve may be relocated at any position on the conduit by twisting the ends and moving to a new position. It has the further advantage of being bendable, which is extremely desirable where bends in the conduit are necessary near the clips. It also gives sufficient strength, durability, and standard size for fastening the clip.

Position Light Flasher

A position light flasher — 12-volt Model 3990 and 24-volt Model 3990A— has been added to the line of the Pacific Division, Bendix Aviation Corporation, North Hollywood, Cal. It has been approved by CAA and the Army, and

Bendix position light flasher

is now in use on U. S. Airlines and on Army trainer planes.

Exclusively designed for aircraft, the flasher is small, weighs only 2.1 pounds, and can be operated at either 12 or 24 volts.

The flasher was built to conform with CAA safety regulations which require commercial aircraft to replace the one white tail light with white and red lights flashing alternately. Each cycle—there must be 40 per minute—consists of 150 degrees of white light, 10 degrees of no light, 150 degrees of red light and 50 degrees of no light. The flashing switches safely handle six amperes in each circuit. This power

(*Turn to page 202, please*)

Al-Fin Process Bonds Aluminum to Steel

Aircooled Cylinders of Ranger Engines Built by New Method

By **Marshall G. Whitfield**
and **Victor Sheshunoff**
The Al-Fin Corp.

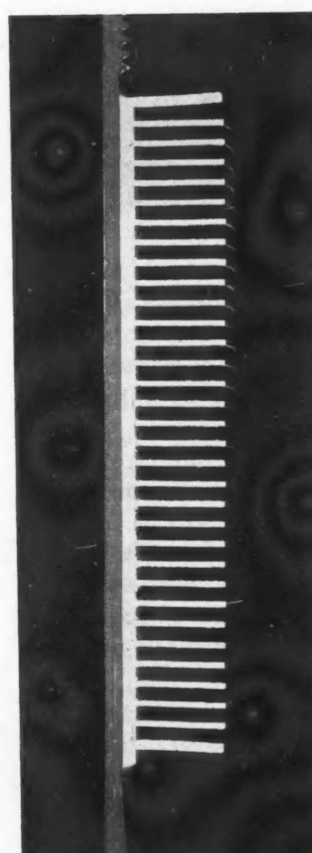
A PRACTICAL method of welding—or, more accurately, of chemically bonding—pure aluminum fins to steel cylinder barrels has been used in the production of Ranger 12 cylinder engines for more than a year. Known as the Al-Fin process, announcement of its development has been withheld until the present for reasons of national security. Through its application in the construction of cylinder barrels for Ranger 12s, power output of these inverted inline aircooled engines has been increased to the point where today they produce more horsepower per pound of weight than any comparable aircraft engine.

Aluminum and copper are two of the most suitable materials for high conductivity fins. Of the two, aluminum enjoys several advantages for this application. (1) The thermal conductivity per unit of weight is higher by 98 per cent. (2) The specific gravity is less by 70 per cent, which results in the aluminum fins being much thicker than equivalent copper fins, with attendant increase in rigidity and freedom from local damage. (3) The resistance against corrosion for aluminum is superior to copper, particularly for aircraft engine applications. Naturally, Al-Fin barrels enjoy greater corrosion resistance than steel-finned barrels.

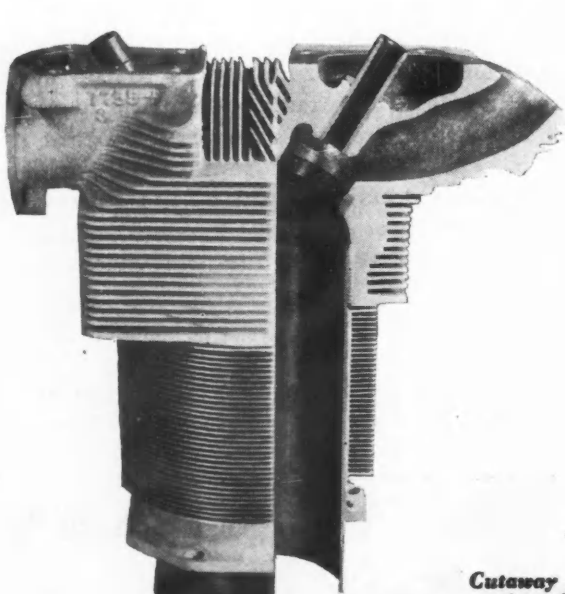
The bond formed between the steel and the pure aluminum by the Al-Fin process is 100 per cent, since it is in chemical composition at that point. The composition of the bond also forms a perfect bridge for the transmission of heat from the steel barrel to the pure aluminum cooling fins. The bond also renders ineffective the difference in expansion characteristics of the two metals. Broadly speaking, the process makes the ductile aluminum expand and contract along with the more rigid steel and supplements the steel with the heat dissipating qualities inherent in the lighter metal.

The Al-Fin cylinder, by test, is stronger than the conventional composite cylinder barrel, the ferric - aluminum bond of Al-Fin having a rupture strength greater than that of pure aluminum. This bond is backed up by the steel barrel's ability to withstand a load of 140,000 pounds per square inch. Moreover,

(*Turn to page* 212)



Section of Al-Fin cylinder barrel showing how aluminum fins are bonded to steel barrel.



Cutaway of cylinder assembly used on Ranger SGV-770 12-cylinder engine. The aluminum finned sleeve was bonded to the steel barrel by the Al-Fin process.


No Thread Seizure!
LONG STANDING, LEAK-PROOF UNIONS DISASSEMBLE READILY!
The lubricating, non-hardening properties of Permatex Pipe Joint Cement permit easy readjustment of pipe lines . . . without thread seizure.
Permatex Pipe Joint Cement is a heavy, brushable, ready-to-use product. It flows easily from the brush, spreads evenly over the threads and "stays put".
The applied film is leak-proof to hot and cold water, steam, salt water, illuminating gas, lubricating oils, gasoline, gasoline vapor, kerosene, ethylene glycol and numerous other liquids and gases.
Permatex Pipe Joint Cement is used wherever pressure-tight, leak-proof unions are required.
PERMATEX
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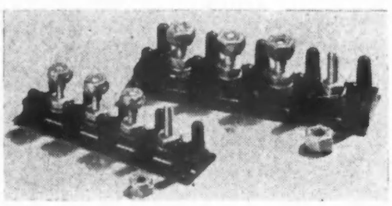
PIPE JOINT CEMENT
PERMATEX COMPANY, INC.
Sheepshead Bay, N. Y., U. S. A.

New Products

Molded Connector Panel Assemblies

Plastic Manufacturers, Inc., Stamford, Conn., is introducing molded connector panel assemblies which are supplied as complete items, ready for installation. These assemblies are known



Molded connector panel assemblies made by Plastic Manufacturers, Inc.

as parts P1, P3-2, and P3-3. All component parts are said to be in accordance with nationally recognized standards that are acceptable to manufacturers of Army and Navy aircraft.

Both P1 and P3 can be ordered in varying lengths to suit requirements as to number of posts needed and available room in junction box assemblies. Variations on the connector panel assemblies can be scheduled where production quantities merit such modifications.

Light-Beam Instrument Measures Flux Density

A light-beam instrument for measuring either flux density or the total magnetic flux in magnetic circuits has been announced by the General Electric Company, Schenectady, N. Y.

The fluxmeter, applicable wherever permanent magnets or d-c electro-magnets are used, is similar to a light-beam galvanometer and has a suspension-type element. By using search coils, which can easily be constructed by the user, it provides a ready means of handling a wide variety of magnetic measurements. It can obtain different sensitivities by utilizing galvanometers of various characteristics. These galvanometers are interchangeable, and the instrument has a scale of 50-0-250 millimeters.

The control box, which contains a dry cell, resistors, rheostat, push button, and a switch, provides a means of introducing a voltage into the electric circuit to compensate for small but undesirable spurious voltages that may otherwise cause errors in high-sensitivity instruments of this type. Moreover, the control box provides a means of returning the spotlight index to the zero position after a measurement has been made.

This instrument for measuring magnetic fields which occur in research, testing and production work, depends for its operation on the use of a direct-current, moving-coil galvanometer of the "compensated" type. In this design, the restoring torque of the suspension is, for all practical purposes eliminated, resulting in a fluxmeter construction which is said to be excellent for work with electric measuring instruments, communication apparatus, motors and generators and contactors and relays. After a flux change has been indicated, the light beam index remains at the point, giving ample time for accurate readings.

G-E Fluxmeter

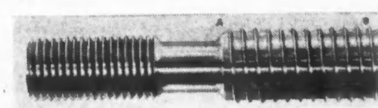
Special Stripper for Blackout Paint

A special blackout paint stripper has been placed on the market by Turco Products, Inc., Los Angeles, Cal. Formulated primarily for blackout paints of both asphaltic and non-asphaltic types, Turco Re-Lite is a ready-to-use stripper with characteristics required for satisfactory application to windows, street light globes and other vertical surfaces. Of heavy body, it clings without runs on any surface. This permits close control with a brush to confine its action to definite areas and also eliminates waste.

In action, Turco Re-Lite is said to be fast and thorough, even on paint which has baked on light globes. It is non-corrosive to any metal, and will not attack concrete, brick and mortar, stone, tile, or marble, according to the manufacturer's claims.

New Dardelet Thread Design

The Dardelet Threadlock Corporation, Detroit, Mich., is presenting a new



Stud with A.N.D. thread

thread design based on the American National thread and has the Dardelet thread principle incorporated. Instead of taking the interference on the flank and flowing the metal into the voids at the root of the thread, which is the custom with the American National thread, this A.N.D. thread design takes the interference at the root of the screw thread and flows the metal into the voids at the flanks. This places all contacting metal under initial pressure due to cold working of the surfaces. As a result, the entire thread engagement is sealed against fretting and fatigue life is said to be greatly improved. The screw is stronger in tension and torsion on account of the larger root diameter. It can be driven into a receiving material, already tapped American National after the threads have been truncated with a straight reamer. The receiving member is tapped with a standard A.N. tap, then the hole is reamed to a predetermined dimension and when the screw is driven in, it burnishes the truncated threads to form the 6 deg. taper.

For assembly, the important dimension is the reamed hole which is held to plus or minus .0005 in. Lead areas are not important and any standard tap is satisfactory. The threads on the screw can be chased, rolled or ground. Gaging is done by the ordinary method. The design, in locking, preserves the locking features of the original Dardelet Thread.

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Production of Combat and Motor Vehicles Declines

Medium Tank Output at Low Point. More Light Tanks and Light-Heavy Trucks Are Being Built

Production of combat and motor vehicles declined 17 per cent in January from December, according to Donald M. Nelson, chairman of WPB, as adjustments in the Army's supply program were made to meet changing battle requirements. The decline ran as high as 50 per cent in the case of motor carriages for self-propelled guns. This has been reflected in cancellation or cutback of the half-track vehicle schedules at White, Diamond T and Autocar. Medium tank output fell to the lowest point since March, 1942, when Chrysler was the only builder of these tanks in production. Heavy truck (over 2½ tons) production fell below the December level, indicating the tight situation in transmissions, axles, transfer cases and bearings. This production must be doubled in the next six months to meet 1944 requirements. Light-heavy truck deliveries, on the other hand, were up 16 per cent from December. Nor were all vehicle shipments downwards. Output of M-5 light tanks, of which Cadillac is the major producer, reached the highest monthly rate since August, 1943. The versatile 2½-ton amphibian truck, the "duck," which has played such an important part in U. S. landing operations, experienced a 67 per cent production increase as the GMC Truck and Chevrolet divisions of General Motors turned out these vehicles on a volume basis.

Overall munitions production dropped two per cent in January from December, the first decline since January, 1943. The WPB munitions index went down to 649 (November, 1941, equals 100) as compared with 661 in November and 662 in December. However, the month's performance in airplanes was the best to date, according to Nelson, due to the increase in urgently needed types. Total planes produced dropped 13 planes from December to 8789, the same as the November total, but on an airframe weight basis aircraft output was up 6 per cent, including spare parts. Navy dive bombers showed up especially well. The January gains or declines on an airframe weight basis by types as compared to December, were: heavy bombers, 111 per cent; medium bombers, 89 per cent; light bombers, 104 per cent; patrol bombers, 99 per cent; fighters, 105 per cent; transports, 112 per cent; trainers, 90 per cent, and communications, 92 per cent. Transports showed the largest percentage increase over December but important models fell far short. Three models of heavy bombers, evidently the B-17, B-24 and B-29, accounted for 42 pounds out of every 100 pounds of airframe weight accepted in January compared to 36 of every 100 pounds six months ago. Termination of contracts for Army trainers was announced recently by the War Dept., affecting Consolidated-Vultee plants at Nashville, Tenn., and Downey, Cal.; the Aeronautical Corp. of America at Middletown, Ohio, and Fairchild Engine & Airplane Corp. at Hagerstown, Md. With the exception of spare parts, these facilities will be converted to parts and subassemblies for combat types.

Airplane deliveries in February totaled 8,760 according to C. E. Wilson, chairman of the Aircraft Production Board, with 43 plants equalling or exceeding their schedules. February output was up 4 per cent from January on an airframe weight basis although the numerical total dropped 29 planes and was 42 below the record December peak. However, February had one less working day than January.

Chevrolet Motor Division of GM, which with its four foundries has become one of the major fabricators of light metals, delivered 76,000,000 pounds of aluminum aircraft forgings in 1943. This ranks it second to Aluminum Co. of America in this field after

(*Turn to page 172, please*)

Sorensen Resigns From Ford Motor Co.

Charles E. Sorensen, vice president and a director of the Ford Motor Co., announced his resignation March 4 at his winter home at Miami Beach, Fla. He joined Ford as a patternmaker in April, 1905, less than two years after the company was founded, and advanced successively to assistant superintendent, superintendent, general manager, and then vice president in charge of production. He directed the laying out and tooling-up of the Willow Run bomber plant.

On his resignation, Mr. Sorensen issued the following statement: "I am resigning as vice president of Ford Motor Company after thirty-nine years of continuous service. I have enjoyed every minute of it, and it is with great regret that I am asking Mr. Henry Ford to relieve me of my duties. The great war program that was developed by the company is well organized and in competent hands. I am compelled to take a much needed rest. I expect to return to Detroit about May 1. I have no immediate plans for the future."

M-16 Anti-Aircraft Unit

The first public demonstration of the new M-16 mobile anti-aircraft unit was given recently on the Cleveland, Ohio, lakefront. The demonstration was staged jointly by the U.S. Army Ordnance Department and The White Motor Company manufacturers of the half-track on which the guns are mounted.

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THE FUNDAMENTALS OF
SEALED POWER LEADERSHIP
Engineering
Facilities
Craftsmanship
Never have we relaxed our efforts in improving these three essential elements for quality. Over 30 years of leadership in supplying major engine builders is proof of the confidence they have in Sealed Power products.
Our engineering staff and laboratories are at your service in making good engines even better.
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Muskegon, Michigan • Windsor, Ontario
SEALED POWER
PISTON RINGS
PISTONS—CYLINDER SLEEVES

Metal Market Dislocated By Lack of Floor Prices

Uncertainty Continues to Surround the Usefulness Of Turnings from Aviation and Other War Plants

By W. C. Hirsch

A unique example of the dislocation of the metal market because of the lack of floor prices to prevent excesses at the other end from where ceiling prices operate to keep values in check is furnished in the record of a sale by the Army of 45,000 pounds of overseas wrecked aviation aluminum at Medford, Mass. The successful bidder offered $41 per net ton. The second highest bid was $11 and the third $10. Offerings of such material at other places have brought out bids of as low as $5 a ton. When, as was the case at the Medford sale, one secondary metal dealer can offer to pay four times the price of a competing bidder for a commodity, in which under normal conditions a fraction of a cent determines transactions, the incident highlights the utter absence of anything like an orderly market and conveys some idea of the state of affairs that would confront metal values in the unthinkable event of an uncontrolled dispersal of much in the way of wartime accumulations. In this connection, the uncertainty that continues to surround the usefulness and, therefore, the value of an important tonnage of turnings that come from aviation and other war plants, is the cause of concern. While permission to use low alloy scrap in carbon steel melts was expected to facilitate solution of this problem, numerous obstacles are being encountered. A large steel company recently announced that it would have to reject all scrap shipments, intended for the making of carbon steel, that contain in excess of .30 per cent nickel and .06 per cent molybdenum. Steel producers say that the use of such alloy scrap would jopardize compliance with rigid Government specifications for finished war material. Not many months ago, a steel mill that had a large reserve of scrap had to appeal to the WPB for supplies free of alloy scrap, to prevent a shutdown. All of which poses the problem of what low alloy steel turnings that are unsuitable for carbon steel melts and the alloys which can not be advantageously segregated are worth. Obviously some dislocation of metal values is an inevitable concomitant of war, even though ceiling prices forestall runaway market conditions.

Payment of premium prices to producers of tungsten will cease April 30, a WPB announcement says. Adequate stockpiles have been amassed. A premium price of $30 per unit of 20 pounds went into effect in November, 1942. The general market price at that time was $24, at which level the Government will continue to buy tungsten after April 30 and until June 30. The Foreign Economic Administration will follow suit in its purchases of tungsten from abroad. Steel producers are awaiting further details regarding important progress, which U. S. Bureau of Mine officials told a Congressional subcommittee had been made in the development of a new steel-making process.

Predicts Diesel Plane Engines in Five Years

Commercial airliners that will burn furnace oil instead of high octane gasoline that costs about four times that amount are foreseen by Gordon Lefebvre, president of The Cooper-Bessemer Corporation.

"It is logical to assume that within the next five years all commercial aircraft engines will be Diesels," said Lefebvre. He based his assertion on the tremendous interest in the Diesel principle of operation that has brought this type of engine to the forefront as the chief source of power for tanks, submarines, cargo and fighting ships and numerous other items of war equipment, and the fact that Diesels have long been well established as prime movers in oil field pumping service, for electrical power plants and in other fields of industrial enterprise.

"In addition to important fuel economies, the Diesel aircraft will also have the inherent advantages of the non-explosive quality of its fuel, plus the absence of electrical interference, one of the most common hazards in air travel," Lefebvre said.

Business in Brief

Written by the Guaranty Trust Co. New York, Exclusively for **Automotive and Aviation Industries**

Somewhat broadened fluctuations of general business activity are currently indicated. The seasonally adjusted index of *The New York Times* for the week ended Feb. 19 stood at 145.5, as against 147.1 in the preceding week and 136.2 a year ago.

Department store sales during the week ended Feb. 26, as reported by the Federal Reserve Board, increased slightly, from 133 to 134 per cent of the 1935-39 average. Total values recorded, however, were 11 per cent below the corresponding figure in 1943, and sales in 1944 to that date were 3 per cent less than the comparable total a year earlier.

Railway freight loadings during the week ended Feb. 26 totaled 782,463 cars, 0.9 per cent more than the preceding weekly figure but 0.1 per cent below the corresponding number in 1943.

Production of electric power during the same period registered an advance, contrary to the usual seasonal trend; and the total was 14.2 per cent above the output a year ago, as against a similar excess of 14.3 per cent shown a week earlier.

Crude oil production in the week ended Feb. 26 averaged 4,423,275 barrels daily, 38,775 barrels above the figure for the preceding week and 4475 barrels more than the average recommended by the Petroleum Administration for War.

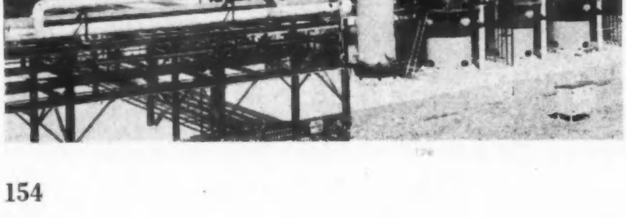
Production of soft coal during the week ended Feb. 19 was estimated at 12,315,000 net tons, 4.9 per cent below the preceding weekly figure but 1.3 per cent greater than the output a year earlier.

Engineering construction contracts awarded during the week ended Feb. 24 totaled $22,161,000, as against $37,-043,000 a week earlier, according to *Engineering News-Record*. Contracts so far reported in 1944 show a decline of 48 per cent from the comparable amount in 1943.

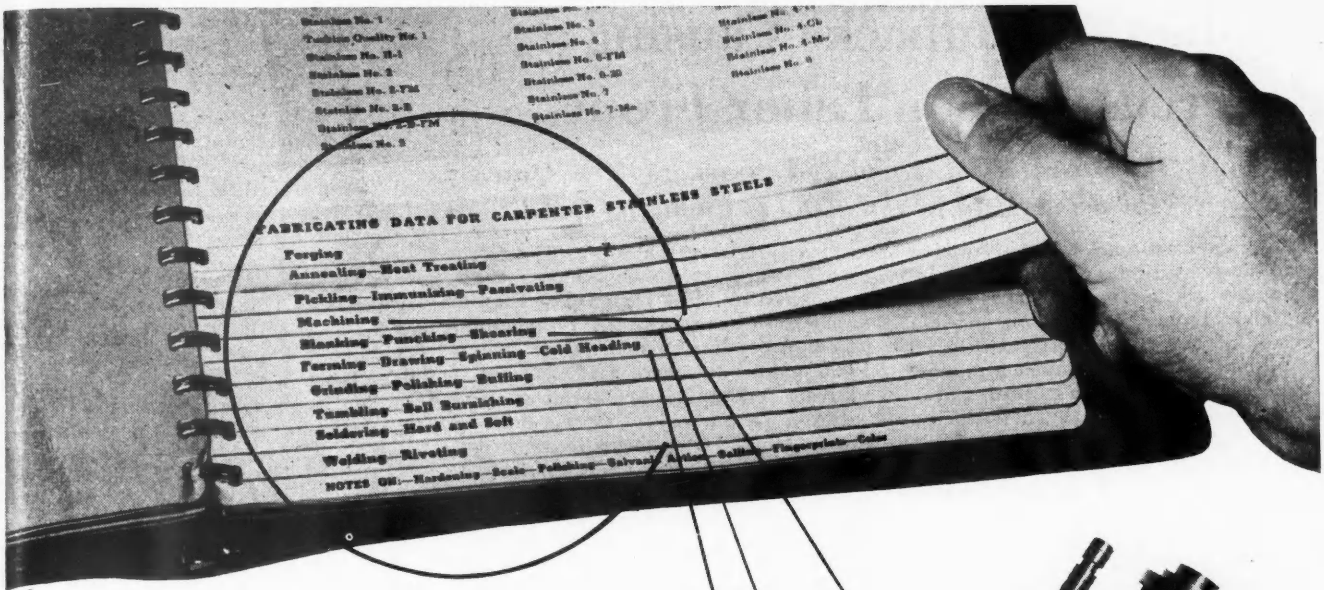
The Irving Fisher index of wholesale commodity prices for the week ended Feb. 25 was 112.8 per cent of the 1926 average, a virtually unchanged level, as compared with 111.1 a year ago.

Member bank reserves increased $271,000,000 during the week ended March 1, and excess reserves rose $100,000.000 to an estimated total of $1,200,000,000. Business loans of reporting members declined $34,000,000 in the preceding week but stood $370,-000,000 above the total a year earlier.

Butadiene for Synthetic Rubber Program



Shown here is one butadiene producing unit of the Institute, W. Va., plant built by Carbide and Carbon Chemicals Corporation for Defense Plant Corporation, and operated for Rubber Reserve Company. This plant is said to be producing butadiene at a rate of over 100,000 tons a year.



HERE'S A GUIDE

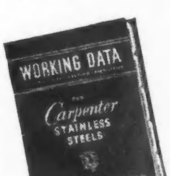
for speeding output of Stainless parts

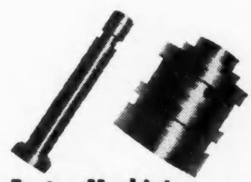
Hard-pressed production men continue to express appreciation for this book "Working Data for Carpenter Stainless Steels", and the many ways it is helping them speed production of vitally needed Stainless parts. Says one production superintendent—

> *"... It has opened my eyes to the fabricating possibilities of Stainless Steel." Says another: "By showing what I can expect in working various types of Stainless, this book has certainly been helpful."*

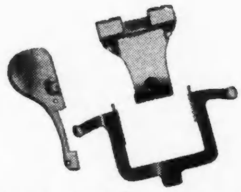
And helping Stainless users to solve fabricating problems is no new job to us at Carpenter. Ever since we pioneered the first bright, ductile Stainless Strip ... ever since Carpenter's invention of Free-Machining Stainless ... our representatives, metallurgists and research men have been in the front line of this business of problem-solving.

It's always been Carpenter's policy to share its "know-how" and experience with Stainless users. So, if you'd like a copy of "Working Data for Carpenter Stainless Steels" drop us a line on your company letterhead. And for personal cooperation on your tough fabricating problems, call in your nearby Carpenter representative.





Easier, Faster Machining, but better valve action, too, because these parts were made from Free-Machining Stainless Steel.



Faster Press Speeds with Stainless that responds easily and uniformly to your press operations. And Carpenter Stainless Strip works the same, coil after coil.

Fewer Rejects on drawn parts, thanks to the uniformity of soft and ductile Carpenter Stainless Strip.

The Carpenter Steel Company • 103 W. Bern Street, Reading, Pa.

Carpenter STAINLESS STEELS

...for
- Strength
- Rigidity
- Heat Resistance
- Corrosion Resistance
- Longer Product Life
- Sales Appeal

BRANCHES AT
Chicago, Cleveland, Detroit, Hartford,
St. Louis, Indianapolis, New York, Philadelphia

Production Cutbacks Causing Repercussions on Labor Front

In Most Cases, Displaced Workers Are Quickly Absorbed After Layoffs Due to Changing Conditions

Government cutbacks in war production, necessitating reduced working schedules, are having repercussions on the labor front. Seven thousand employees of the Briggs Mfg. Co. Mack Ave. plant in Detroit staged a one-day strike recently in protest over Saturday closing of the plant. The reduction from the usual 48-hour week was made necessary when three prime contractors for Navy planes who Briggs furnishes with airframe subassemblies were unable to accept the parts as rapidly as they were produced and a backlog had accumulated. The UAW-CIO accused the company of poor work scheduling and said the diligence of the workers was being penalized. Meanwhile, Briggs announced that 1,500 of the plant's 13,000 workers would have to be laid off, at least temporarily, for retooling on some plane parts. Briggs has been negotiating with the UAW-CIO over renewal of the contract which expired last Nov. 13. The former contract contained a maintenance of membership clause but the company said it would not agree to renewal because of the union's drive for dues that disrupted several plants in December. However, the National WLB ordered the maintenance of membership provision continued pending the determination of 13 other contract issues before the board.

Thompson Products, Inc., laid off 1,500 employees at two Cleveland plants when an airplane engine manufacturer suddenly cancelled its orders for valves and parts. Remaining employees were put on a 5½-day week instead of 13 days every two weeks. Displaced workers were quickly absorbed by other Cleveland industries but then Thompson Products received new war orders and had to appeal to the USES for more workers. The Curtiss-Wright Corp. plant in St. Louis had to lay off 1,500 employees during the retooling period on cargo planes but when production was resumed, a new employment peak was expected to be reached. The Douglas Aircraft Co., Inc., plant at Tulsa, Okla., dismissed 3,700 workers in December and expects to lay off 4,000 more next July when the plant retools for increased output of cargo planes. Douglas expects to reemploy 3,000 of the 7,700 workers when full production is attained on cargo planes.

When the Evansville (Ind.) Ordnance Plant of Chrysler Corp. had to dismiss more than half of the 12,000 employees there due to cutbacks in the small arms ammunition program, it set up facilities in the personnel office where other Evansville industries, such as Briggs Mfg. Co. and Indiana Division of Republic Aircraft Corp., could interview the departing workers. Interviews were given to 5,785 of the former Chrysler employees and many were hired by other companies. Similar methods were used at the Philadelphia plant of Bendix Aviation Corp., where 1,000 employees were laid off due to contract terminations resulting from "altered requirements of the military forces." The USES sent 35 interviewers to the plant and in one day most of the dismissed workers had been referred to other war plants. Piper Aircraft Corp. at Lock Haven, Pa., reverted from a 48 to a 40-hour week and let out 298 employees when trainer plane production was curtailed. Of those released, the USES referred 184 to other war jobs in the vicinity. When White Motor Co. had its contract for half-track combat vehicles cancelled, the 500 workers laid off there were taken on by other Cleveland plants of the same company. Likewise, at Akron, cutbacks in the airship program at Goodyear Aircraft Corp. resulted in the shift of 400 women employees to the neighboring Goodyear plant producing Vought Corsair fighter planes, where output was on the increase.

Donald M. Nelson, chairman of WPB, recently explained the shifting production situation to leaders of organized labor when he asserted, "We are going to be cutting down on some types of munitions because in certain cases we have now built up adequate stockpiles for the moment. However, let us be perfectly clear about one thing: even though some of us can stop making certain munitions which are now in surplus, very few of us are going to be

(Turn to page 168, please)

Obituary

Arthur H. Kudner, 53, president of Arthur Kudner, Inc., New York advertising agency, and widely known in the automotive field, died suddenly Feb. 18 at Los Angeles. His agency handled the Buick, Allison, and Fisher Body accounts. Kudner started in the advertising business in 1915 with the Cheltenham Advertising Agency in New York. In 1929 he became president of Erwin Wasey & Co. and in 1935 launched his own agency.

Dr. Leo H. Baekeland, 80, the chemist who invented bakelite, died Feb. 23 at his home in Beacon, N. Y. In 1910 he founded the General Bakelite Company, which later became the Bakelite Corporation.

Jesse Jay Ricks, 64, chairman of the Board of Union Carbide and Carbon Corporation, died Feb. 20 at his home in Plandome, N. Y., after a brief illness. Mr. Ricks became chairman of the Board of Union Carbide and Carbon Corporation in 1941. He had been president from October, 1925, to May of 1941.

Charles H. Oishei, vice president and Detroit representative of Trico Products Corporation, Buffalo, died Feb. 24 following a fall at his home in Miami, Fla. He was a brother of Jack Oishei, president of Trico Products Corporation.

Marvin J. Steele, 56, assistant chief engineer of the marine engine division of Packard Motor Car Co., died Feb. 29 at Detroit following an operation. He had been with Packard since 1912. During World War I he worked on the development of the Liberty aircraft engine at Dayton, Ohio. He also helped develop the Packard marine engines that powered the Miss America craft with which Gar Wood won the Harmsworth Trophy and which later were adopted for installation in Navy PT boats.

ARMY E NAVY

Awards

Names and winners of Army-Navy "E" awards in or allied with the automotive and aviation industries, announced since the March 1 issue of AUTOMOTIVE AND AVIATION INDUSTRIES went to press:

THE BREWER-TICHENER CORPORATION, Cortland Forging Div., Cortland, N. Y.

THE BRISTOL BRASS CORPORATION, Bristol, Conn.

THE BRYANT ELECTRIC COMPANY, Hemco Plastics Div., Bridgeport, Conn.

CLARKE AERO-HYDRAULICS, INC., Pasadena, Cal.

DETROIT GASKET & MANUFACTURING CO., Marine City Plant, Marine City, Mich.

DETROIT STAMPING COMPANY, Highland Park, Mich.

THE FIRESTONE TIRE & RUBBER CO., Firestone Cotton Mills, Inc., Gastonia Plant, Gastonia, N. C.

GENERAL MOTORS CORP., Brown-Lipe-Chapin Div., Syracuse, N. Y.

HERCULES POWDER COMPANY, Pluto Plant, Ishpeming, Mich.

MADISON-KIPP CORPORATION, Madison, Wis.

MUEHLHAUSEN SPRING COMPANY, Logansport, Ind.

TUNG-SOL LAMP WORKS, INC., Newark, N. J.

WEIRTON STEEL COMPANY, Weirton, W. Va.

"E" Star Awards

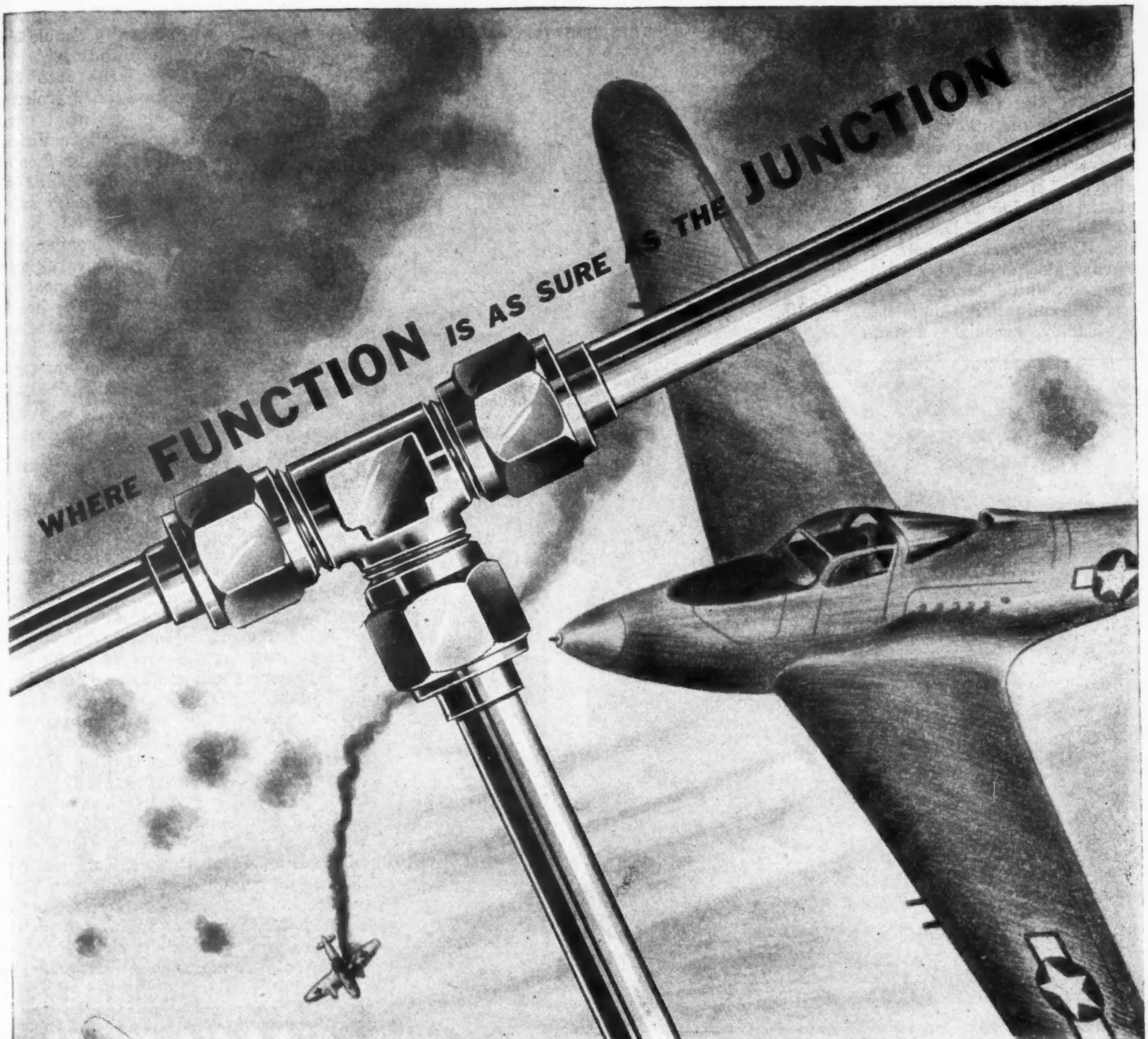
for continued meritorious services on the production front have been awarded to the following firms:

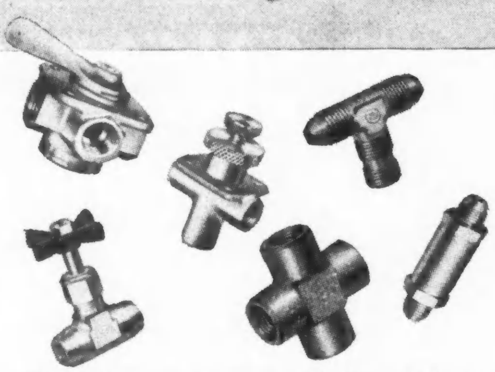
P. R. MALLORY & COMPANY, Indianapolis, Ind.

HANDY & HARMAN, New York, N. Y.

BORG WARNER CORPORATION, Norge Div., Muskegon Heights, Mich.

ANTHONY COMPANY, INC., Streator, Ill.





In a single plane the junctions securely formed by Dole Aircraft Valves and Fittings run into the thousands. Thus, the strict *accuracy* of Dole engineering and factory operations contributes to the victorious performance of American planes; In our small way, we make doubly sure they will keep functioning in situations where the enemy's will fail.

Made in accordance with Army-Navy Aeronautical Standards

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THE DOLE VALVE COMPANY
ESTABLISHED 1906
1901-1941 Carroll Ave., Chicago 12, Illinois
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★

Buy War Bonds and Stamps

AIRCRAFT VALVES AND FITTINGS

Phil S. Hanna Joins Staff of ACWP

Phil S. Hanna, business editor of the *Chicago Sun* for the past two years, has joined the staff of the Automotive Council for War Production as assistant to George Romney, the managing director. Hanna previously was editor of the *Chicago Journal of Commerce* for 10 years and Detroit manager of the *Wall Street Journal*. Richard S. Purdy, also assistant to Romney, has been appointed secretary of the Contract Termination Committee. Harlan V. Hadley, associate manager of the Council's Manpower Division, has been named acting manager of the Washington Reporting Service and William Norton, of the Detroit staff, also has been assigned to Washington.

More Space for Houdry Process Laboratories

Laboratory facilities of the Houdry Process Corporation, Wilmington, Delaware, are being expanded, according to a recent announcement by Eugene J. Houdry, president. The new addition will add floor space to the main research laboratories of Catalytic Development Corporation, Linwood, Pa. The expansion will virtually double the working space in that building.

"The continuing research into the catalytic transformation of petroleum has brought about the essential need for increasing our research facilities. To this end an extension of brick and reinforced concrete is being added to our present building," Mr. Houdry said. "The new extension will permit additional working space to accommodate chemists, technicians, engineers and assistants. Upon completion, most of the corporation personnel will be headquartered at the Linwood laboratories, under the corporation's operating subsidiary, the Catalytic Development Corporation."

New DPC Contracts

National Bronze & Aluminum Co. has received a Defense Plant Corporation contract for $1,900,000 to provide plant facilities at Cleveland. Briggs Mfg. Co. has had its DPC contract increased $670,000 for expansion of a Detroit plant. Packard Motor Car Company has been granted an additional $635,000 for more equipment. Budd Wheel Company has received $60,000 for equipment and machinery in a Detroit plant.

Boeing Aircraft Company has had its contract boosted by $2,500,000 for additional plant facilities at Benton, Wash., making the total commitment $21,700,000. Kaiser Cargoes, Inc., has been awarded an increase of $730,000 for additional plant facilities for the Fleetwings Division at Bristol, Pa., making the overall commitment $3,900,000. Republic Aviation Corporation has been allotted $150.000 for additional plant facilities at Farmingdale, N. Y., bringing the total commitment to $18,000,000.

CALENDAR

Conventions and Meetings

Northwest Aviation Exposition, Minneapolis — Mar. 25-April 1

American Society of Tool Engineers—Annual Mtg., Philadelphia — March 26-28

American Chemical Society, Cleveland, — April 3-7

SAE Natl. Aeronautic Meeting, New York — April 5-7

Midwest Power Conference, Chicago, — April 13-14

American Chemical Society Spring Mtg. of Div. of Rubber Chemistry, New York City — April 26-28

~~Institute of the Aeronautical Sciences~~—Natl. Light Aircraft Mtg., Detroit, — April 27

SAE Natl. Diesel-Fuels & Lubricants Meeting, Chicago — May 17-18

SAE Natl. War-Materiel Meeting, Detroit — June 5-7

American Society for Testing Materials (47th Annual Meeting), New York City — June 26-30

SAE Natl. Transportation & Maintenance Meeting, Philadelphia — June 28-29

SAE Natl. West Coast Transportation & Maintenance Meeting, Portland, Oregon — August 24-25

PUBLICATIONS

The Cleveland Cap Screw Co. has announced publication of its new Catalog F, covering **cap screws, set screws, aircraft bolts, nuts** and other fastener items. The catalog is thumb indexed for convenient reference and includes complete dimensions and weights.*

The Dayton Rogers Mfg. Co. has announced the distribution of a framed **decimal equivalent chart** with glass protected table.*

A 48-page booklet, **Air Cargoes,** issued by the Robert Gair Co. contains a comprehensive survey of the future of flying freight and express, specific packaging information and detailed reports of tests made in Gair laboratories and in actual use by commercial shippers and the armed forces.*

The Construction of Plywood Shipping Containers is the title of a new booklet issued by the Douglas Fir Plywood Association. It provides some new basic information on plywood as the result of a number of tests conducted by the research department of the Association.*

A bulletin entitled **Interesting Applications of the Cincinnati No. 2 Cutter and Tool Grinder,** compiled from articles in the trade press, has been issued by The Cincinnati Milling Machine Co. It contains information on the technique of grinding milling cutters with resinoid bonded wheels so as to provide a super-finish; it also illustrates the operation of producing carbide-tipped flat boring cutters.*

The Hydraulic Press No. 36, issued by The Hydraulic Press Mfg. Co., contains valuable production material of interest to our readers. A section describes in detail the many diversified applications of H-P-M Fastraverse presses in Boeing's Wichita plant; another tells of the use of such equipment in producing carbide tools and a third deals with the application of H-P-M multiple unit injection machines for molding plastics.*

Aerco Corp. has issued a 4-page, 2-color folder regarding its **hydraulic multi-grip milling machine chuck.** It contains complete information, illustrations, specifications and prices on both models of the new Aerco Chuck.*

Plastics Bulletin No. 22, issued by the Plastics Dept. of E. I. du Pont de Nemours & Co. contains an interesting article on **Polythene,** a new plastic by du Pont.*

General Electric Co. has announced the publication of Bulletin GEA-4157, which describes the **fluxmeter and fluxmeter galvanometers** and includes drawings of search coils.*

The Sterling Varnish Co. has published Bulletin 243, entitled **Sterling Speedair-bonds** containing descriptions of a group of air-drying, insulating varnishes designed for use in the manufacture and repair of electrical equipment. It also describes various Sterling specialty products such as stripping compound, balancing compound, rust preventatives, commutator paints, identifiers, etc.*

A 4-page folder on its line of **V-belts,** featuring information about its recently announced wire grommet type, has been published by The B. F. Goodrich Co.*

* Obtainable by subscribers within the United States through Editorial Dept. AUTOMOTIVE *and* AVIATION INDUSTRIES. In making requests for any of these publications, be sure to give date of the issue in which the announcement appeared, your name and address, company connection and title.

AVCO Establishes Publicity Bureau

The Aviation Corporation has established its own publicity bureau to handle information and publicity covering Lycoming and Spencer Divisions of Williamsport, Penna., American Propeller and Northern Aircraft Products Division at Toledo, Ohio, and Republic Aircraft Products Division plants at Detroit, according to an announcement of William F. Wise, executive vice president of AVCO.

This publicity bureau will be located at the offices of The American Propeller Corporation, Toledo, Ohio, under the supervision of Arthur W. Gratop.

Wheelco Instruments Co. Changes Hands

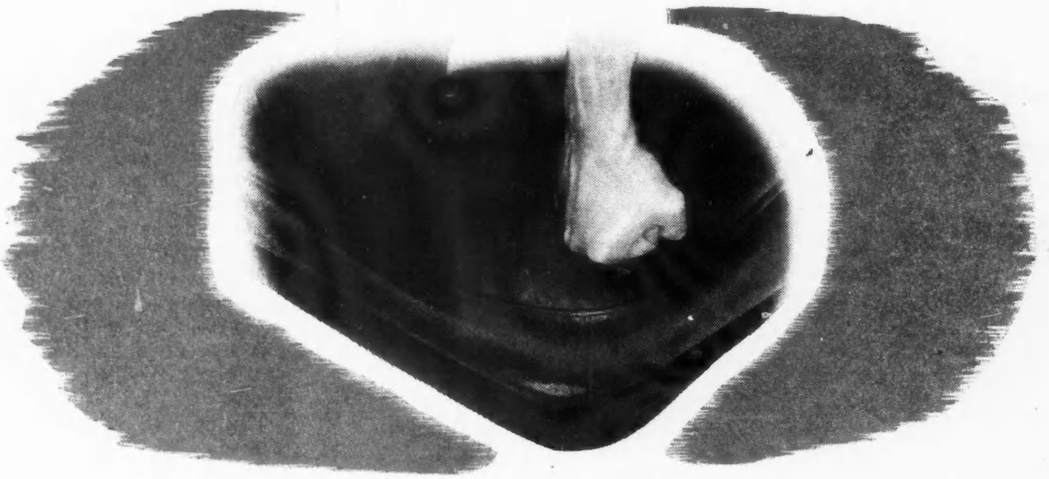
Assets of Wheelco Instruments Co., Chicago, have been purchased by Fred A. Hansen and Cary H. Stevenson, vice presidents of the Lindberg Engineering Co., Chicago, and several associates. The business of the industrial instruments firm will be continued at the same location under a new corporation, the Wheelco Instruments Company.

Officers of the new company are Hansen, president; Stevenson, secretary and treasurer; and Richard Schoenfeld and Theodore Cohen, vice-presidents of the old company, as vice presidents. Schoenfeld will be in charge of sales and production.

Hansen and Stevenson will continue to be active in management of Lindberg Engineering Co.

Vinylite

TRADE-MARK



Taxicab Proving Ground—for a new upholstery material

A new VINYLITE Plastic upholstery material that was developed in time to find useful service on jeeps, 'planes, and tanks, was installed in a taxicab, before the war, to test its durability. The taxicab was an excellent proving ground. The illustration shows the driver's seat, covered with the new VINYLITE Plastic material, just as it appeared after a hundred thousand miles of hard driving. Cab drivers do not spare the upholstery they ride on, yet the seat still looks newly-upholstered.

The answer is the VINYLITE Resin Compound calendered on the upholstery cloth. A rubber-like plastic that shows none of rubber's weaknesses, it makes possible upholstery materials that do not oxidize, therefore will not crack upon aging. This new type upholstery possesses remarkable wear and abrasion resistance. Grease does not soil it; soiling is no longer a problem, because it can be wiped clean easily with a damp cloth. And it can be produced in a range of colors, in many unusual surface effects, and in natural leather grains.

VINYLITE Resin Compounds for upholstery have the same outstanding properties as the VINYLITE Elastic Plastics that are being used today for aircraft paulins, bomber floor mats, and inflatable equipment. They offer much to today's aircraft builders, promise much for tomorrow's cars. For technical assistance and more detailed information, please write Department 15.

Plastics Division
CARBIDE AND CARBON CHEMICALS CORPORATION
Unit of Union Carbide and Carbon Corporation
UCC
30 EAST 42ND STREET   NEW YORK 17, N. Y.

Plastics

Technical Discussion Program Will Be Covered in Two Days at ASTE Meeting

One of the most significant technical programs ever sponsored by the American Society of Tool Engineers has been announced for the Annual Meeting of the Society scheduled for March 26 to 28 inclusive at Philadelphia, Pa.

Despite the number of subjects covered, however, it has been found possible to so schedule technical discussions as to cover the entire program in two days of technical sessions—the 27th and 28th.

Featuring these sessions is the presentation at one session of a series of papers discussing all the factors relating to the putting into production and production itself of a vital war product. Scheduled for Monday morning, the 27th, it will cover by papers presented by departmental heads of a major industrial producer, the engineering, planning for production, tooling, actual foundry and machining production, and inspection methods, etc., relating to this one product.

Monday afternoon's session will be devoted to new developments in the way of surface finishing methods, with particular stress on honing through papers by Kirk W. Connor, President, Micromatic Hone Corporation, Detroit, and A. F. Hasty of Sunnen Products Company, St. Louis.

Monday evening's meeting is devoted to the integrating of manufacturing, tooling, and personnel to produce war products, with William Jack of famed Jack and Heintz in Cleveland revealing the principles on which this company based its production achievements as well as an analysis of the merits of the plan from a technical standpoint in terms of results achieved.

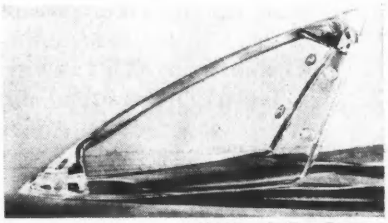
Tuesday morning's session is devoted to electronics as applied to machining. The session is in the form of a symposium with papers by T. R. Lawson of the Electronic Control Section of Westinghouse Electric & Mfg. Co., R. A. Cole, Experimental Engineer of the Grinding Machine Division, Norton Company, and B. T. Anderson, Electrical Engineer, Sundstrand Machine Tool Company.

Fly-cut milling and broaching form the nucleus of discussions at the Tuesday afternoon session, the former being presented by Ralph R. Weddell, President, Weddell Tools, Inc., Rochester.

The annual meeting will be brought to a close Tuesday night with the annual banquet at which John H. Van Deventer, Editor of *The Iron Age*, is the principal speaker, discussion "The Tool Engineer and the Post War World." Ray H. Morris, A.S.T.E. President, will preside at the banquet, with A.S.T.E. past-president T. B. Carpenter as Toastmaster. Installation of officers for 1944-45 will also take place at the Banquet, together with presentation of the annual membership trophy award.

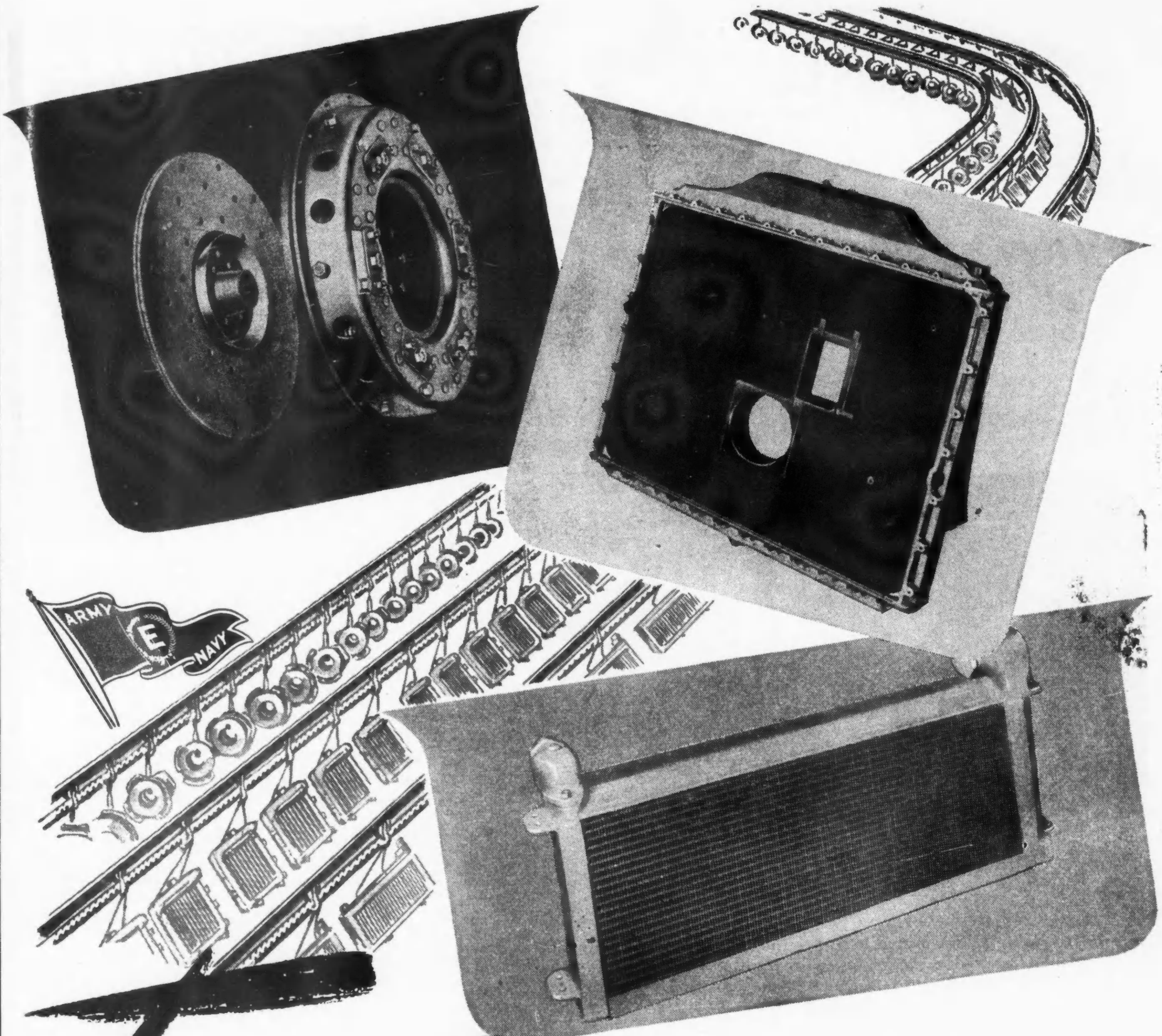
The technical sessions will be preceded on Sunday the 26th by meeting of various A.S.T.E. National Committees as well as an all-day meeting of the Board of Directors of the Society.

Protection for Aircraft Lights



Courtesy du Pont Company

Wing tip of the Martin B-26 Marauder is made of "Lucite" methyl methacrylate resin which protects lights that are carried for identification and to assist pilots and airport control towers in getting the planes up and down safely at night. "Lucite" is used to make the covers or lenses for lights on both military and commercial planes.



Facilities

Growing steadily with the automotive industry since 1903, Long has built up the trained personnel, the production equipment and the knowledge necessary for continuous, quality production. Today, Long clutches, radiators and oil coolers serve the Allies on land, sea and air, around the world. Tomorrow, they will again be available for America's peacetime transportation and industry.

LONG MANUFACTURING DIVISION
BORG-WARNER CORPORATION
DETROIT, MICH. • WINDSOR, ONT.

LONG
CLUTCHES • RADIATORS • OIL COOLERS

PERSONALS

The election of **William A. Irvin**, former president of the United States Steel Corp., as a director of Willys-Overland Motors, Inc., has been announced.

The White Motor Co. has announced the appointment of **Roger Weider** as executive bus engineer, to serve under **William Naegel**, general manager of the Coach Div.

Bert Conway has been named vice president in charge of manufacturing of The Aviation Corp. For the past year he has been manufacturing coordinator for the Corporation as production and tooling adviser at all AVCO manufacturing plants.

L. M. Bach has been promoted to the position of general works manager in charge of manufacturing operations at all Lockheed A and B factories.

The Goodyear Tire & Rubber Co. has announced that **L. K. Hanson** has been recalled from Mexico City to manage Pliofilm foreign representation for the Goodyear's export division.

Purolator Products, Inc. has announced the election of **Clarence E. Searle** to the Board of Directors. He is vice-president in charge of sales and a member of the Board of Worthington Pump & Machinery Corp. Purolator has also announced the appointment of **Howard J. Hopkins** as assistant sales manager with jurisdiction over After-Market Sales in the Eastern States.

The National Screw & Mfg. Co. has announced the appointment of **Don D. Greenshields** as manager of the production department.

W. G. McFadden, formerly assistant district sales manager of Allegheny Ludlum Steel Corp.'s Chicago office, has been appointed district manager of that territory.

Harold J. Siekmann has been advanced to the position of chief engineer of the R. K. LeBlond Machine Tool Co., to succeed **Wm. F. Groene**, retired.

Niles-Bement-Pond has announced the appointment of **Richard F. V. Stanton** as assistant manager of the machinery sales dept.

Paul M. Snyder has been appointed sales manager of the Climax Molybdenum Co., with headquarters in Canton, Ohio.

Pyrene Mfg. Co. has announced the following promotions of sales and advertising personnel. **Nelson Bauer**, Newark District Manager since 1929, has been made assistant general sales manager. **Raymond F. Poole**, assistant district manager at Chicago is now Newark district manager. **Frank R. Kachel**, sales representative in Chicago has been appointed assistant district manager to succeed Mr. Poole and **Truman Young**, assistant advertising manager has been made advertising manager. He continues as advertising manager of the Pyrene affiliate, the C-O-Two Fire Equipment Co.

Ray J. Cowden has been appointed sales manager of Lycoming Div. of The Aviation Corp., Williamsport, Pa. For the past two years he has been contract and service engineer at the American Propeller Corp. of Toledo.

Philip H. Clapp has been appointed abrasive division district manager for the Pacific Coast by Norton Co. **Donald L. Price** has been appointed abrasive division district manager in Detroit succeeding Mr. Clapp.

Directors of the National Malleable & Steel Casting Co. have elected **Cleve M. Pomeroy** vice-president. He will also continue as secretary and treasurer.

The appointment of **Leslie G. Brown** to the position of assistant to the vice-president in charge of operations of Braniff Airways has been announced.

George Selden has been appointed manager of the Flexwood and Flexglass Div. of the United States Plywood Corp.

The appointment of **Miles Powell** as field manager of the WHIZ automotive div. of the R. M. Hollingshead Corp. has been announced.

Ralph H. Maxon, president of the Tyson

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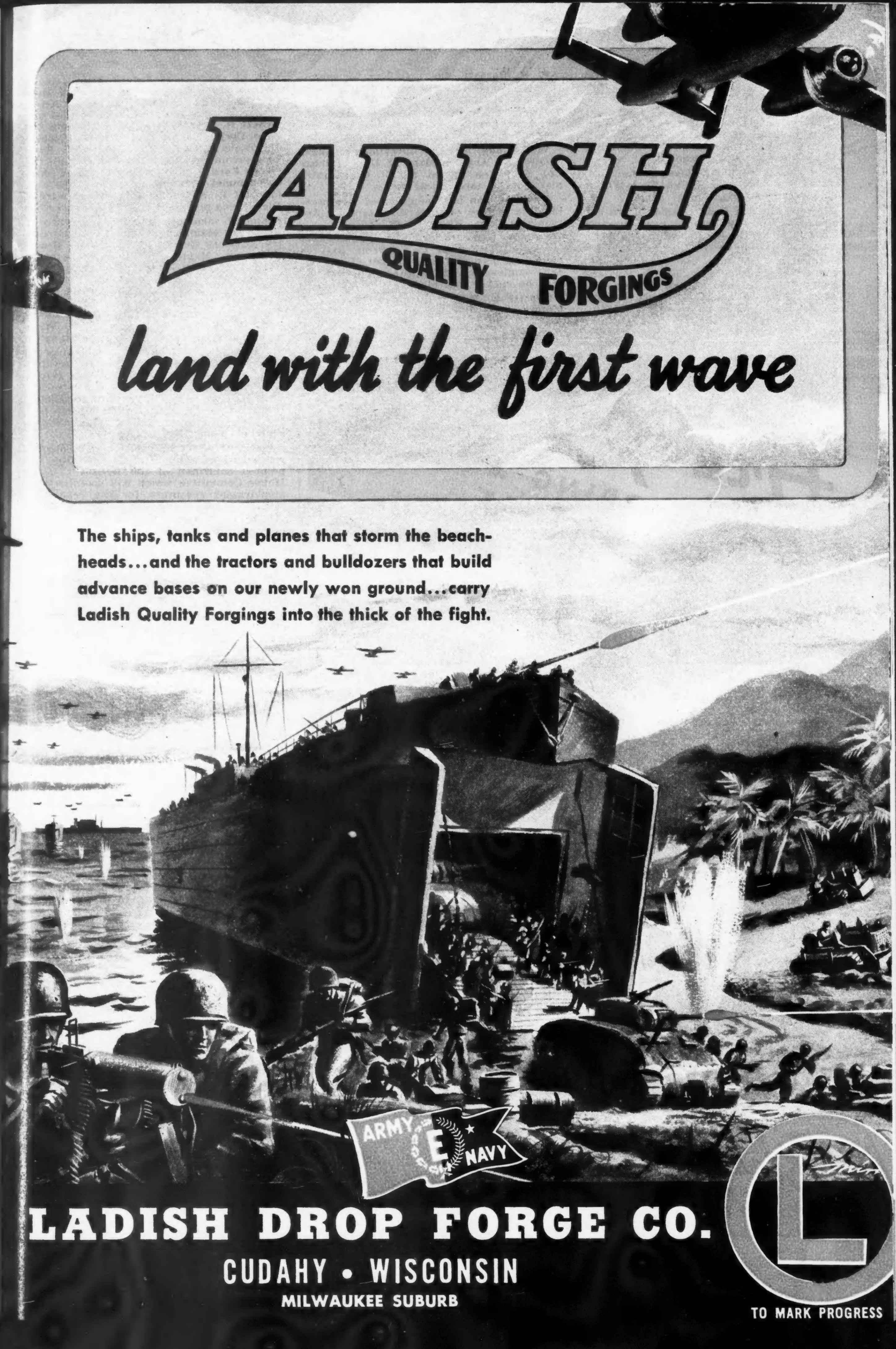
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QUALITY FORGINGS
land with the first wave
The ships, tanks and planes that storm the beach-heads...and the tractors and bulldozers that build advance bases on our newly won ground...carry Ladish Quality Forgings into the thick of the fight.
ARMY E NAVY
LADISH DROP FORGE CO.
CUDAHY • WISCONSIN
MILWAUKEE SUBURB
L
TO MARK PROGRESS

Bearing Corp. of Massillon, Ohio, has resigned and **John K. Colgate** has been elected by the board of directors as his successor.

The appointment of **George A. Siedemer** to the position of manager of accessories and repair materials sales, for Seiberling Rubber Co., has been announced.

David A. Coleman has been elected vice-president of the Lake Shore Tool Works, Inc., of Chicago.

Howard Hall, of Cedar Rapids, Iowa and **James E. Sweeney** became new directors of Kropp Forge Co. and Kropp Forge Aviation Co. at its annual meeting.

Paul H. Townsend, vice-president and general manager of the Huron Portland Cement Co., has been elected a director of Federal Motor Truck Co., succeeding the late Frank H. Whelden.

P. R. Bassett, vice-president for engineering, also will serve as acting general manager of Sperry Gyroscope Co., Inc.

Frank T. Magennis, formerly assistant manager, has been elected vice president of Goodyear Tire & Rubber Export Co.

W. S. Long, formerly operations manager of the Los Angeles plant of U. S. Rubber Co., has been named Pacific Coast sales manager for mechanical goods.

Ira S. Wilson has been elected vice president in charge of finance of Aircraft Accessories Corp., Kansas City, Mo.

Paul W. Lehman, formerly chief engineer of the U. S. Rubber Co., Detroit, has resigned to join Giffels & Vallet, Inc., Detroit engineers and architects, as consultant on rubber and plastics.

Charles E. Wilson, president of General Motors, has been re-elected board chairman of the Traffic Safety Association of Detroit. **John S. Bugas,** of the Ford Motor Co., has been elected a director. Among new trustees of the association elected were **Ernest R. Breech,** president of Bendix Aviation Corp.; **Harvey C. Fruehauf,** president of Fruehauf Trailer Co.; **Walter E. Rockwell,** president of Timken-Detroit Axle Co.; **Henry Ford II,** vice president of Ford Motor Co.; **Emmet Sheahan,** assistant to the president of U. S. Rubber Co., and **Howard E. Blood,** vice president of Borg-Warner Corp.

Among members appointed recently to the WPB Magnesium Sand Casting Industry Advisory Committee are **Wiser Brown,** American Magnesium Corp., Cleveland; **Fred A. Foxall,** Bendix Aviation Corp., Teterboro, N. J.; **J. R. Gould,** Springfield Bronze & Aluminum Co., Springfield, Mass.; **Samuel J. Walker,** Michigan Light Alloys Corp., Chicago; **Leo B. Grant,** Dow Chemical Co., Midland, Mich., and **J. A. Weinman,** Los Angeles Magnesium Castings Co.

Joseph H. O'Malley, vice president of the industrial engine and marine engine divisions, has been appointed assistant general sales manager of the Chrysler Division of Chrysler Corp. He will continue to function in his former capacities. O'Malley has been the division's liaison officer with the government since 1941.

Henry J. Roesch, director of industrial relations for Briggs Mfg. Co., has been appointed chairman of the Detroit Clearing House Committee which will coordinate all employment resources for the rehabilitation of returning servicemen.

E. C. Hetherwick has been elected vice president and general manager of Hayes Industries, Inc., Jackson, Mich. He also will continue as treasurer. **William J. Donahue** has been elected secretary and assistant treasurer.

Albert W. Lavers, formerly chief engineer of the Minneapolis-Moline Power Implement Co., has joined Harry Ferguson, Inc., distributor of Ford tractors, as industrial tractor engineer.

Paul E. Minsel, formerly a member of the labor relations staff of General Motors Corp., has been named head of the new industrial relations dept. of Eaton Mfg. Co.

Milton A. Holmes, at one time a sales executive with Republic Motor Truck Co., Reo and Continental Motors Corp., has been appointed acting Detroit regional manager of the Smaller War Plants Corp.

T. B. Hale, manager of domestic sales, and **F. W. Jenks,** manager of the credit and collection departments, have been elected vice presidents of International Harvester Co.

J. J. Donovan, assistant director of the Automotive Division of WPB since 1912, has resigned to become New York regional manager of the Airtemp Division of Chrysler Corp.

R. W. Hofheins has been appointed field technical engineer by Willys-Overland Motors, Inc.

J. W. Frasche has been appointed plant manager of the new tire factory of B. F. Goodrich Co. now under construction in Miami, Okla.

Lloyd D. Brace, vice president of the First National Bank of Boston, has been elected a director of Republic Aviation Corp.

George Miller, formerly budget supervisor, has been named a sales executive and member of the general sales staff of Chrysler Division, Chrysler Corp.

Ralph E. Morgan, Lee Oldfield and **Clarence M. Wetzel** announce the formation of the Laboratory Equipment Co., Mooresville, Ind., to supply technical service in connection with the installation and use of engines. Oldfield was formerly chief engineer of the Merz Engineering Co., Indianapolis.

James H. S. Ellis, formerly executive vice president, has been elected president of Arthur Kudner, Inc., succeeding the late Arthur Kudner. He has been in charge of copy and planning since the agency was formed in 1935.


Snap-on Tools
THE CHOICE OF BETTER MECHANICS
Not even the finest, fastest hand tools can perform production miracles ... *but they help!* Throughout victory-geared industry, Snap-on tools are on the job ... helping speed America's incredible output of planes, ships, weapons. Snap-ons are *speed* tools, designed to help mechanics turn out *more* work and *better* work, with less effort and greater safety. Snap-on's direct-to-user tool service is available through 35 factory branches located in key production centers. Write for catalog of the complete Snap-on line.
SNAP-ON TOOLS CORPORATION
8054-C 28th AVENUE • KENOSHA, WISCONSIN

Production Cutbacks

(*Continued from page* 156)

able to return to the production of civilian items. The expanding munitions program will continue to require the energies of an overwhelming proportion of labor and management."

In a survey of the nation's manpower needs for the first six months of 1944, Paul McNutt, WMC chairman, said that it is expected that employment in the munitions industries must be maintained at the January level through July. He said that substantial upward and downward changes in the production of specific items will be reflected in employment levels of various industries and areas. Aircraft, landing craft, communications and electronic equipment and ship repair are scheduled to increase, while production of ammunition, small arms, anti-aircraft artillery and tanks are due to decline. Reflecting these changes, Chicago, Moline, and Rockford, Ill., recently were added to the Group I critical shortage areas by WPB, while Indianapolis and Monroe, Mich., were dropped from Group I to Group II due to an easing of labor requirements. Kalamazoo has been moved up from Group III to Group II, anticipating a labor shortage, while Toledo has been dropped from Group II to Group III.

Matthew Smith, secretary of the Mechanics Educational Society of America, independent union of skilled craftsmen, threatened the National WLB with another strike if a decision is not given soon on whether independent unions are to have board representation in disputes before the WLB. Smith called a three-day strike in 44 plants represented by the MESA in February over an attempt by the UAW-CIO to organize tool room employees at Willys-Overland Motors, Inc., in Toledo, who already belonged to the MESA. Smith recently was the inspirational force behind a three-day convention at Cincinnati of the Confederated Unions of America, which he organized at Chicago in October, 1942. Fifty-eight unions claiming 500,000 members were represented at the Cincinnati parley, which authorized an 11-man delegation to visit Washington and seek representation for independent unions on labor panels of government agencies. Smith promised a no-strike pledge if the independent unions are given representation. Meanwhile, the MESA defeated the UAW-CIO, 471 to 353, in an NLRB election at the Adrian plant of Bohn Aluminum & Brass Corp.

Taking recognition of increasing unauthorized work stoppages, the international executive board of the UAW-CIO took steps at its quarterly meeting in Los Angeles to prevent repetition of them. In cases of wildcat strikes, the international union will conduct an investigation to determine the causes, provocation by the management and identity of the union members involved. If union members are found responsible for agitating or causing a work stoppage, all services to such members and intervention on their behalf will be withheld in event of disciplinary action by management. In addition, the international union can instruct the local to cause charges to be filed and prosecuted against the responsible members in accordance with the UAW-CIO constitution.

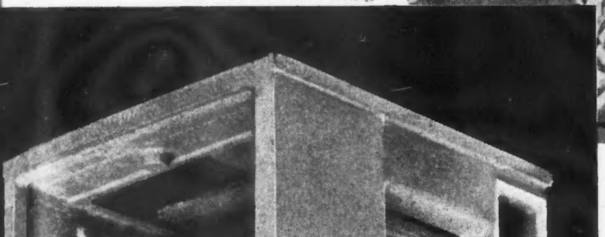
Tomkins-Johnson Appoints Buffalo Representative

The Industrial Equipment Co., Buffalo, N. Y., formerly the R. C. Neal Company, has been appointed sales representatives for Tomkins-Johnson products in that territory. Under the supervision of C. C. Tiedman and G. H. Schliecker, the Buffalo firm will now handle the line of T-J air and hydraulic cylinders, "Rivitors" and "Clinchers."

Advertising Notes

Howard G. Knowlton has joined MacFarland, Aveyard & Company as vice president and account executive. The appointment is a continuation of the agency's expansion program during the last year, during which personnel and facilities have been doubled.

Aerial cameraman readying a Fairchild Camera for use from the air. Note camera is covered by electrically heated leather jacket to protect it from the severe weather encountered.



The Casting shown is for an automatic reconnaissance aerial camera. It weighs only 12.3 pounds before machining.

RECONNAISSANCE planes, whose job it is to help secure aerial photographs of enemy movements and territory, are given *extra* altitude by any weight-savings in equipment carried.

The designers of Fairchild Aerial Cameras contribute toward this weight saving by utilizing Hills-McCanna Magnesium Alloy Sand Casting in the removable roll film magazine and the central portion of the camera lens cone.

The remarkable lightness of magnesium metal combined with exceptional strength and durability may offer just the thing you need in your post-war products. Let us discuss your projected peace time plans and products.

FOUNDERS OF NON FERROUS ALLOYS SINCE 1870

HILLS-McCANNA CO.
3015 N. WESTERN AVE. · CHICAGO

PROPORTIONING PUMPS · AIR & WATER VALVES · CHEMICAL VALVES
MARINE VALVES · FORCE-FEED LUBRICATORS · DOWMETAL CASTINGS

Production of Combat and Motor Vehicles Declines

(Continued from page 152)

only 18 months' experience. This is almost a 10-fold increase from 1942 output of 8,200,000 pounds of aircraft forgings. The Chevrolet Grey Iron Foundry at Saginaw turned out 2,000,000 pounds of magnesium castings in eight different types for Chevrolet-built Pratt & Whitney aircraft engines in 1943. Eighty per cent of the aluminum forging output came from Chevrolet foundries at Detroit and Saginaw. Other foundries at Muncie and Anderson, Ind., supplied the rest of the total. Among the different aircraft forgings produced are crankcase sections, tail wheel housings, landing gear trunnions, airframe braces and struts, cylinder head air deflectors and pistons of several types. The Saginaw plant produces four types of propeller blades at a monthly rate of 30,000 individual blades, including some eight-foot blades for super-bombers.

Value of special tooling for the mass output of war products is illustrated by the case of a large manufacturer of liquid-cooled aircraft engines. When the first pilot line was set up on these engines, parts were produced on a job shop basis. Twenty-nine machine tools were utilized on the crankcases, with 230 direct labor hours per crankcase and spoilage averaging 47.6 per cent. When the first big production increase was received from the government, many operations were further mechanized to almost triple daily output. Thirty-two new machines were purchased, which resulted in cutting the direct labor hours per case to 125 and scrap to 6.4 per cent. Another doubling of production schedules brought about a realignment of manufacturing practice and the abandonment of many standard machines, such as six radial drill presses, in favor of special-purpose machines. Two specially designed boring mills were installed to perform simultaneously 18 operations formerly done individually. Although production was increased 92 per cent, nine regular boring mills were made available for other work. This cut the direct labor hours per crankcase to 40 and eventually to 32 after another doubling of schedules while spoilage was reduced to less than 4 per cent. Sixty-six machines now perform the crankcase production job to achieve a 10-fold increase over the original daily schedule. This is only five more machines than were used to meet schedules one-fourth as great. Milling machine operations have been so combined and simplified that 16 milling machines now produce four times as many crankcases as did 14 milling machines previously.

An automobile company that supplies the aircraft engine manufacturer with crankshafts had similar experience in machine tool utilization. On the original pilot line, 24 machines were used on the crankshaft at a cost of 93 direct labor hours and spoilage of 50 per cent. The first production increase resulted in addition of 17 machines, cutting direct labor hours to 78 and scrap to 40 per cent. As schedules were doubled and then doubled again, machines required on the crankshaft job increased to 64 and then 98, while direct labor hours per crankshaft dropped progressively to 71 and then 53½. Meanwhile, spoilage had declined to 9 per cent.

The Evansville (Ind.) Ordnance Plant, which Chrysler Corp. converted from a Plymouth branch assembly plant to small arms ammunition production, has been reduced to a 50 per cent operating rate in line with recent cutbacks in that program. Since this plant went into production early in 1942 after the government letter of intent was received Jan. 15, 1942, it has produced 2,732,393,000 caliber .45 and .30 cartridges. Cost per thousand cartridges has been cut $15.43. The $26,000,000 materials used included 38,000 tons of steel, 3,000 tons of copper, 42,000 tons of lead, and 23½ tons of zinc plating.

A GASKET *that* simplifies design

. . . saves time, cuts costs, seals securely

FOR gasket applications like that shown above—the sealing of a valve rocker arm cover—cork offers a unique combination of advantages. Cork is impervious to oil. Cork is highly compressible and resilient. Cork gives a tight seal even in light-pressure assemblies of lightweight metal stampings. No side bolts are needed.

Armstrong's Cork Gaskets have been widely used for such jobs for many years, because no other material has been found that will provide so tight a seal at so little cost.

Armstrong makes several types of cork composition for gasketing purposes. Compositions with a wide range of physical properties are available either plain or coated with oil and graphite for use as oil seals . . . coated with resins, synthetic rubbers, or glue for imperviousness to certain liquids or gases . . . or laminated with cloth, treated paper, or fiber for additional mechanical strength.

In addition to cork compositions, Armstrong supplies the automotive and aviation industries with gaskets, packings, and seals made from a variety of other materials. These include cork-and-synthetic-rubber compositions, cork-and-rubber compositions, synthetic-rubber compositions, rag felt papers, and fiber sheet packings. Most of these materials are available in sheet and roll goods, cut gaskets, strips, tapes, molded shapes, and extruded rings.

For samples of materials that will meet your specific sealing requirements, send assembly drawings and pertinent operating data to Armstrong. Write, too, for complete information about any of the other Armstrong specialties listed below. Address Armstrong Cork Company, Industrial Division, 1503 Arch Street, Lancaster, Pa.

ARMSTRONG CORK COMPANY

MATERIALS AND SPECIALTIES FOR AIRCRAFT AND AUTOMOTIVE UNITS

- **Gaskets, packings, seals,** piston cups, bushings, and valve seats—for gauges, fuel lines, meters, hydraulic systems, and other equipment
- **Composition roll goods,** with or without fabric back, plain or adhesive-coated—used as glazing strip, binding tape, cushion pads, anti-skid flooring, and gaskets
- **Tank strap cushions**
- **Sealing materials** for specialized aircraft equipment handling aromatic fuel
- **Felts** for vibration-damping and soundproofing
- **Wingwalk materials**
- **Resilient floorings**
- **Carburetor floats** and other fabricated natural or composition cork specialties

BOOKS . . .

GAS TURBINES AND JET PROPULSION FOR AIRCRAFT *by G. Geoffrey Smith, M.B.E.*, the managing editor of two of England's leading aircraft magazines, FLIGHT and AIRCRAFT PRODUCTION, is the first book to deal entirely with aircraft propulsion plants employing combustion gas turbine and axial compressor combinations. It has 80 pages measuring 5½ in. by 8½ in., and, following a foreword, editor's note and historical sketch, there are ten chapters having the following titles: I Jet Propulsion for Aircraft, II Propulsion Units Employing Rotary or Reciprocating Compressors, III The Thermal Jet Principle; Influence upon Design, IV Potential Advantages: Compressorless Schemes, V First Recorded Flights of the Caproni-Campini, VI Steam Turbines for Jet or Airscrew Propulsion, VII Demand for Greater Power Output: Limitations of the Reciprocating Engine: Possibilities of the Gas Turbine, VIII Gas Turbines for Airscrew Propulsion, IX New Gas Turbine Projects, X Turbines and the Flying Wing.

It is obvious from the subject matter covered in these chapters that this new and intriguing problem is presented in a very complete manner. Moreover, it should be evident, too, that gas turbines and jet propulsion developments have reached a stage where we may expect numerous practical applications in the future.

Designed to serve the purpose of a manual for the solution of problems that arise in lubricating engines and machinery is a text entitled LUBRICATING OF INDUSTRIAL AND MARINE MACHINERY, by *William G. Forbes*. The author points out that in the practice of lubrication engineering there are few convenient formulas that provide rule-of-thumb answers. Consequently, the text treats with the fundamentals of latest developments in petroleum technology and refinery practice, defines the terms used in connection with the production and testing of petroleum products. Later chapters touch on the theory and practice of bearing lubrication; and the lubrication of generic types of machinery such as—steam engines, steam turbines, hydraulic turbines, gasoline engines, Diesel engines, gas compressors, reduction gears, machine tools, etc.

The author also has prepared a supplementary text, entitled LUBRICANTS AND CUTTING OILS FOR MACHINE TOOLS which is really an expanded excerpt of certain portions of the larger text mentioned above. This provides a small, handy manual for those who are primarily interested in machine shop metal cutting problems. Both books are published by JOHN WILEY & SONS, INC.

Alloy Iron Cutting Tool Holders

Since conservation of tool steels has become essential, alloy cast iron has been increasingly adopted for lathe tool shanks and milling cutter bodies. Instead of making the entire cutter out of tool steel the latter is used only in the actual blades which are inserted and replaced singly as needed when worn down or broken in service. In lathe tools, high speed steel or cemented carbide tips are brazed or soldered to alloy cast iron shanks. Though adopted as a wartime measure, the performance of alloy iron in the applications promises to assure its retention, even after all restrictions are lifted in the post-war era.

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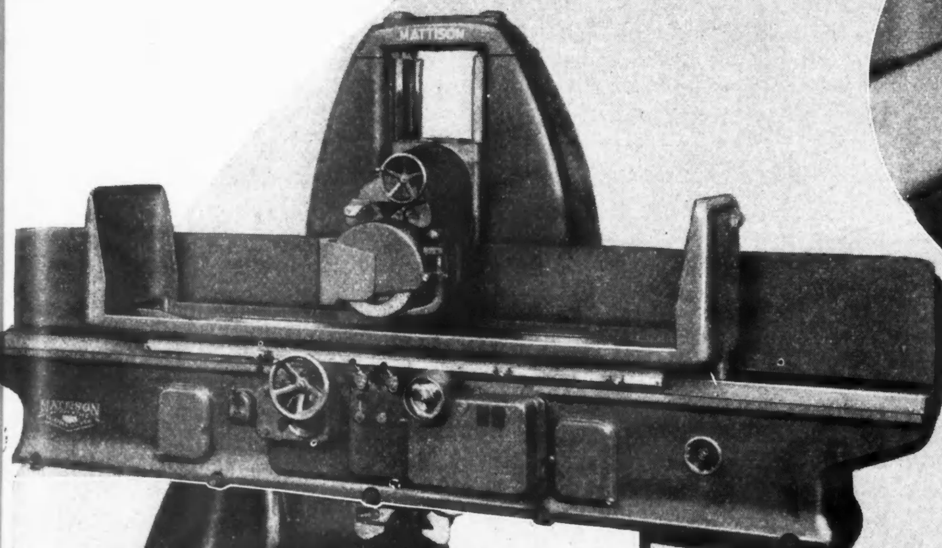
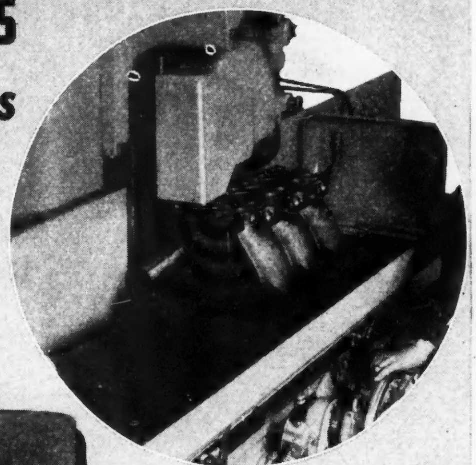
RIES

MATTISON SURFACE GRINDERS

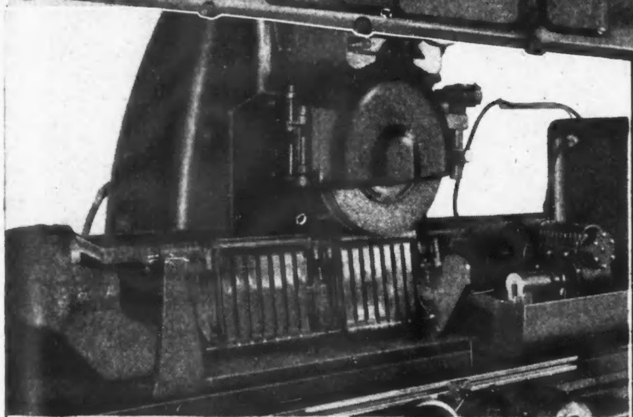
"IN LINE" AT WRIGHT PLANTS

PRECISION WORK on a High Production Basis

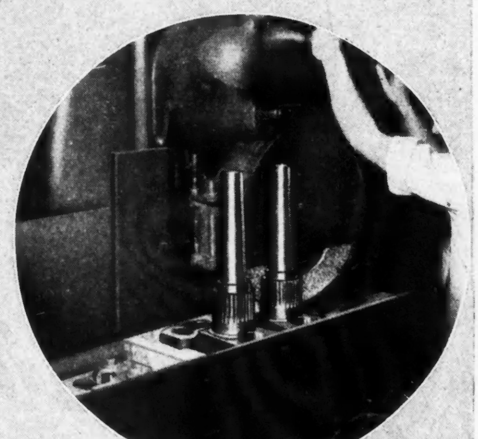




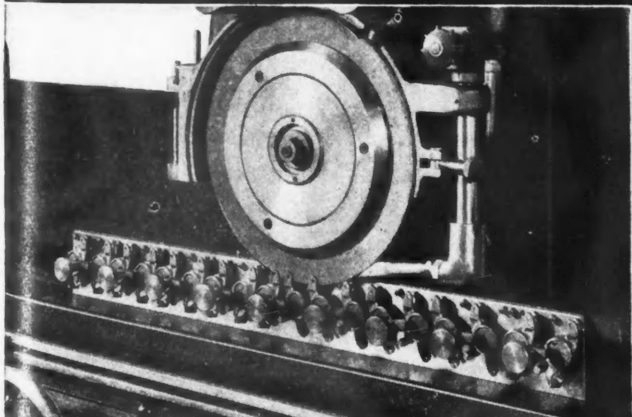
Exhaust manifolds are finish-ground both sides to very close tolerances. Its ability to turn out work to close limits of accuracy at a high production output makes the Mattison Grinder ideal for finishing of aircraft parts.



Mattison Surface Grinder with special fixture for grinding the radius at end of articulated rod. A formed wheel is used with the rods indexed for rough grinding; then the fixture is oscillated by power while the table reciprocates to finish-grind the radius, producing a fine finish and accurate radius.



Grinding face of crank cheeks for counter-weights. 14 cylinder cyclone engine. Held by magnetic chuck. Ground to very close limits. Also form-ground on the radius at the junction of the cheek with the body of the shaft.



Narrow slots in end of rocker arm are ground by Grinder. Special fixture allows holding these parts in accurate alignment while slot is ground. With this arrangement several pieces at a time are accurately ground.

★ ★ ★ ★ ★ ★ ★

Mattison Surface Grinders have proven their value for use in the production of aircraft parts where close precision and high output are required. A few of the factors which account for the success of Mattison Grinders are, the massive double-column support for the wheel-head, high power for rapid stock removal, large table capacity, smooth double-cylinder hydraulic table-drive, simplicity of operation and highly accurate construction. Illustrated are a few typical aircraft applications of the Mattison Grinders at the Wright Aeronautical and Curtiss-Wright Plants.

MATTISON MACHINE WORKS
ROCKFORD, ILLINOIS, U. S. A.

British and German Aircraft Developments

By M. W. Bourdon
Special correspondent of Automotive and Aviation Industries in Great Britain.

Information has been released in England regarding a new version of the Handley Page Halifax four-engined heavy bomber, the type of machine that, in conjunction with the Avro Lancaster in particular, has played and still is playing such a prominent part in night raids on German cities. The chief difference between this latest Halifax, known as the Mark III, and the two earlier versions is the use of four 1650 hp Bristol Hercules XVI engines in place of the Rolls-Royce Merlin 22 engine fitted to the Halifax II. The Hercules, it may be recalled, is a 14-cylinder air-cooled radial with sleeve valves. Its possible future adoption as an alternative to the Merlin was taken into consideration when the Halifax was being planned as far back as 1938; the aircraft design provided for engine interchangeability without need for extensive structural alterations.

The increase in power derived from the Hercules XVI engines has resulted in appreciably better performance of the Halifax. Precise information on this point cannot be given for security reasons, but it is stated that the improvement has concern with take-off, rate of climb and, in combination with an increase of 5 ft. in wing span (now 104 ft), a step-up of several thousand feet in the service ceiling and a higher maximum speed. The drag of the extra wing span has been offset by the lower induced drag and better angle at which the newest Halifax flies.

Halifax III also embodies differences in defensive armament from that of the first version to go into operational service in 1941. Halifax bombers originally had a two-gun turret in the nose, a two-gun dorsal turret and a four-gun turret in the tail. The Mark III retains both the rear and the dorsal turrets, but the latter is now of the four-gun Boulton-Paul electro-hydraulic type, displacing the Hudson type two-gun installation. As in the Halifax II, the front turret of the Mark I has been discarded and replaced by large and wholly transparent Perspex nose of improved shape from the aerodynamical standpoint. As reported on a previous occasion in Automotive and Aviation Industries, British experience in night raiding shows that head-on attack rarely occurs, so the front armament of Halifax III consists solely of a hand-operated .303 in. machine gun projecting through the center of the transparent nose for use by the bomb aimer when required.

Halifax III differs also from the early type in the twin fins and rudders. A slight tendency of the machine to yaw has been completely eliminated by the fitting of fins of different shape and larger area. Then, with the change of engine type, the propellers have been changed, the de Havilland hydromatic type with metal blades replacing the Rotol propellers with blades of compressed wood.

Handley Page Transport Machine

Co-incident with the issue of the foregoing information concerning the Halifax III, the first details of a Handley Page transport plane have been made known. At present it is officially nameless. It has been developed from the Halifax III, and has the new Hercules engines and seems to bear the same relation to the latest Halifax as the Avro York transport plane bears to the Lancaster heavy bomber. It is

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TRIES

Design Problems of the Postwar Tractor

THE tractor engineers' work will not be finished until there is a tractor on each farm and there are still some four million farms not tractor equipped. That was one of the potent thoughts left with those who attend the Tractor and Industrial Power Meeting of the Chicago Section meeting of the Society of Automotive Engineers in February. The speaker of the evening was Leonard B. Sperry, assistant to the vice-president of engineering, International Harvester Co., who has been associated with tractor engineering for 35 years. In his talk Mr. Sperry brought to light some interesting facts. They were supplemented by comments in the form of prepared discussions presented by W. F. Strehlow of Allis-Chalmers Manufacturing Co., and W. H. Worthington of the John Deere Tractor Co. While the 200 or more engineers and guests who attended the meeting left with no preconceived design fixed in their minds as to the exact composition of the postwar tractor, they did accumulate ideas and suggestions very pertinent to it.

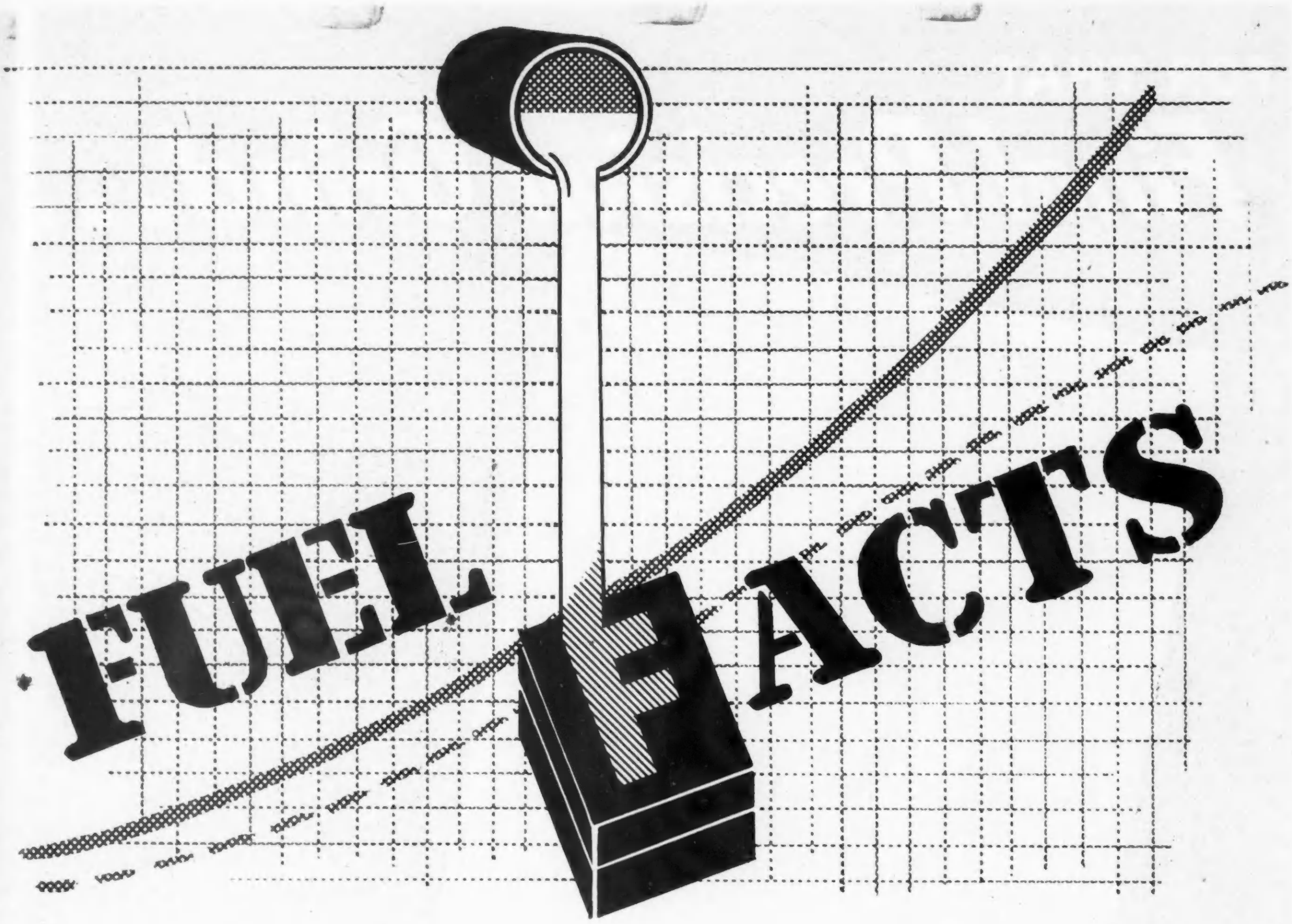
In the opening period of his talk Mr. Sperry traced, with the aid of lantern slides, the high points of tractor design from the early days of the steam-driven jobs to modern types. Pointing out that the "graveyard efforts" of manufacturers usually are not public property, Mr. Sperry had of necessity to use largely the historical background of his own company's product. While the steam tractor was a real step forward in power plowing, it had its problems. As the speaker stated, the outfit was very heavy, required a licensed engineer, needed a huge amount of water which often had to be hauled a long distance, there was always the danger of explosion and so on. And all this, in spite of the fact that the gas engine was known before the steam tractor came into vogue.

Nor was the gas engine given a green light immediately in the early years of the present century. Many doubted the general acceptance of the gas engine where steam had been used and in 1910 Mr. Sperry said, his company had on hand a uni-flow type steam engine, fully developed and ready for use in case the gas engine did not work out satisfactorily in their tractor.

The dirt problem nearly killed the whole tractor idea in its early years of development. Exposed gears, difficulty of lubrication, rapid wear of parts, etc., together with the problem of cleaning the air for the carbureted mixture did much to encourage the continual use of the horse on the farm.

In tracing the gradual development of tractor history, Mr. Sperry stated that not until about 1923 was there a marked swing towards putting mechanical power on the farm. A major step towards replacement of horses was

(*Turn to page 182, please*)



According to science, the amount of heat or energy in molecules of gas or oil is practically limitless.

Until a way is found to put this tremendous energy to work, and control it, we can only hope to use the heat released by burning the gas or oil with air which is a chemical reaction releasing a certain amount of heat.

How much of the available heat is utilized for actual melting depends upon (1) fuel mixture control, (2) combustion control, (3) heat absorption and (4) insulation.

All of these are scientific MUSTS in the engineering and construction of Fisher Furnaces—and the secret of Fisher's consistent fuel economy record.

FUEL IS VITAL—LET FISHER HELP YOU SAVE IT!

Bulletins are available—

on the complete line of Fisher Furnaces, Blowers, Burners and Refractories for crucible or pot type non-ferrous furnaces—write for any or all of them. Present your layout problems to Fisher.

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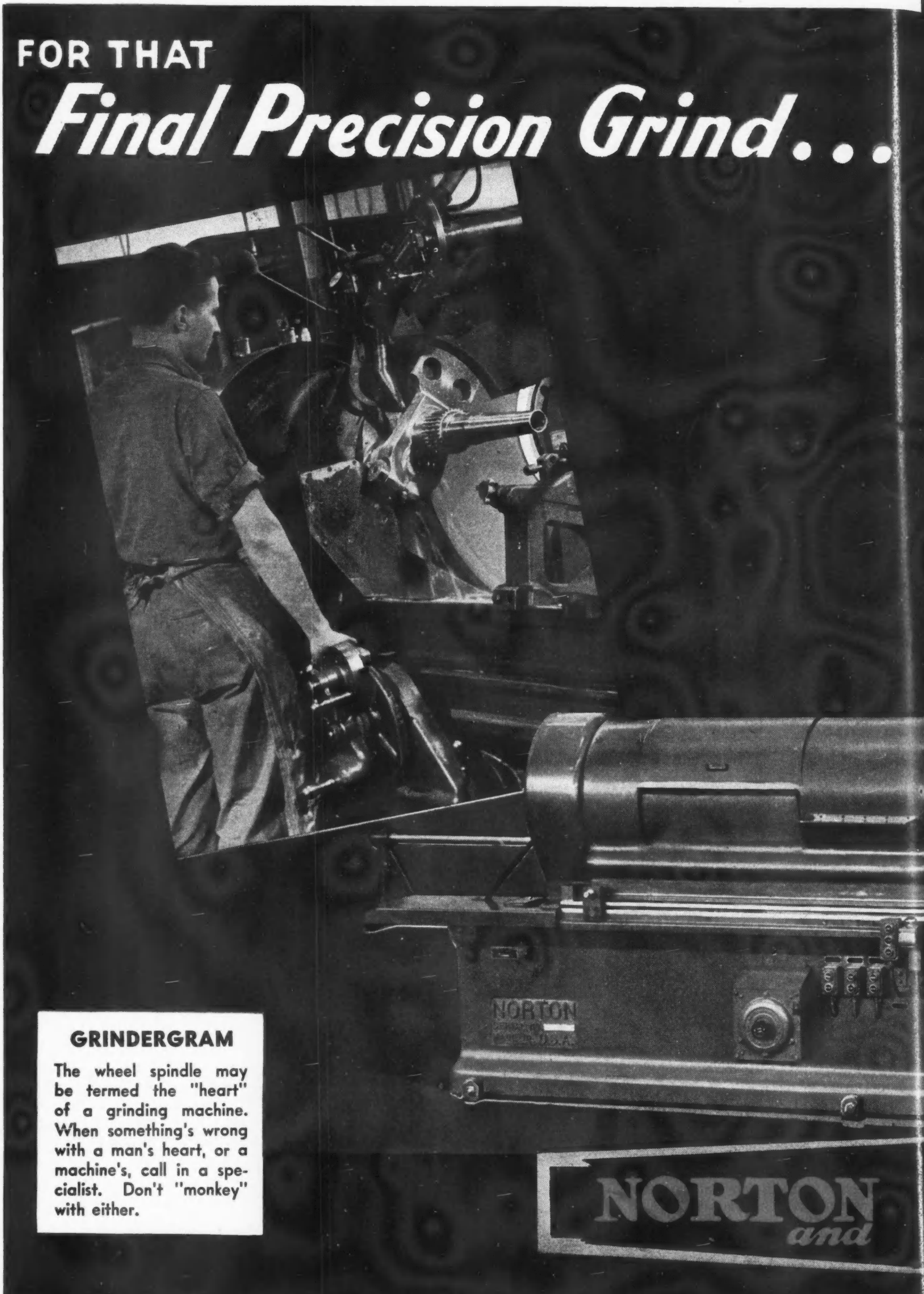
Fisher FURNACE COMPANY

Engineers and Manufacturers


FOR THAT
Final Precision Grind...
NORTON
GRINDERGRAM
The wheel spindle may be termed the "heart" of a grinding machine. When something's wrong with a man's heart, or a machine's, call in a specialist. Don't "monkey" with either.
NORTON
and

(*Continued from page* 178)
made that year. Up to that time it had been largely a matter of merely relieving horses. Along about 1918 the statisticians said there was one tractor to eight horses on farms. Even as late as 1942 the ratio has not changed materially, since it is said to be one tractor to seven horses. Thus, as the speaker said, the farmer evidently has not as yet found the answer in mechanized equipment for his farm and is compelled to retain horses not only as stand-by equipment, but for constant use.

The speaker went on to say that tractors must be simplified or the horse will stay on the farm. Also tractors as yet cost too much for farms of medium size. A versatile, medium-priced tractor which can be afforded by every farmer is evidently the postwar goal of the tractor engineer. Various things may help to expedite it, such as the increasing trend towards diversified farming in the South. This definitely should create a new need for tractors. Mr. Sperry also said that three or four farmers in a community may buy a tractor for joint use on their farms, which again would increase the potential for new tractors.

Steel will continue to be the dominant material in the postwar tractor, Mr. Sperry said. This must necessarily be so because the tractor is pulling and not carrying a load. There is little on the horizon of design to indicate that steel or cast iron will be replaced, since tractors need weight. Aluminum and other alloys no doubt will find their way into the engine and other units of the postwar tractor.

Plastics, he said, have a very limited use in this field, since temperature and shock conditions are the chief sources of trouble. The speaker was high in his praise of rubber tires, stating that they constituted the biggest improvement in tractors for many years. Mr. Sperry stated that the synthetic tire has great possibilities in this field.

Postwar tractor designers should give operating comfort serious attention. The old-fashioned iron seat, for example, is a carry-over from the old days and should come in for its share of redesigning. Long hours, without rest periods, on the part of the farmer make him literally cry out for more comfort. The same holds true for better weather protection.

Then there is safety. Mr. Sperry assured his audience that electric starting would be original equipment on all tractors after the war. Something will have to be done by designers on tractors' speeds and center of gravity location. High road speed and a high center of gravity are not conducive to safety in all-around operation.

Fuel and fuel handling will come in for their share of attention because fuel cost becomes an important item of operating cost with the farmer. Postwar fuel may change tractor engine design but regardless of this, the final result for which engineers will strive is the cheapest possible farm power with low grade fuel.

In his discussion of Mr. Sperry's paper, Mr. Strehlow advocated postwar tractor designs so new that owners of old tractors will turn in their equipment. Some of the old models have been in service for so many years that the problem of supplying replacement parts becomes acute.

Other points that came up in the discussion period included a plea for better location of the exhaust line, simplification of lubrication by cutting down the number of lubrication points, engineering implement and tractor hitches together so that one make of tractor can quickly be coupled to an implement of another make. It should be recalled that the old type of tractor with lugs on the steel wheels could dig itself into the level of the implement, which is not so with the rubber tired vehicle.

This issue of
AUTOMOTIVE *and*
AVIATION INDUSTRY
is for Year 'Round Use

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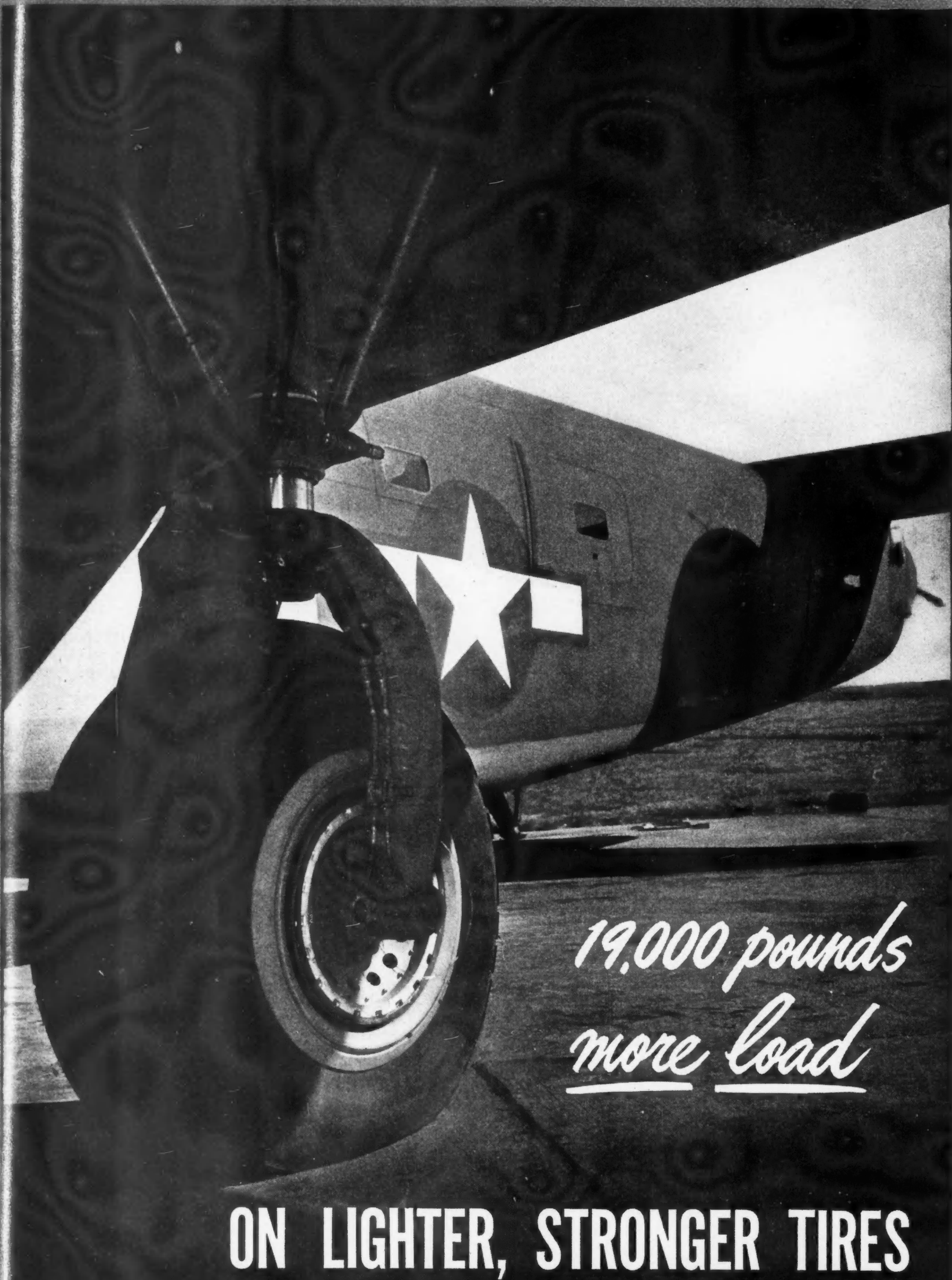

19,000 pounds
more load
ON LIGHTER, STRONGER TIRES

WEIGHT OF CONSOLIDATED LIBERATOR
...Yet The Same Size U.S. Royal

HERE COMES 60,000 POUNDS OF BOMBER!

60,000 pounds of bomber...and what a bomber it is! From Ploesti to Rome and Berlin and from Guadalcanal to the Marshalls and the Gilberts, the enemy has felt the devastating weight of the destruction the Liberator carries.

In 1940, the B-24 was equipped with seven machine guns...four 30 calibre and three 50 calibre. A crew of six was required to operate her...and her total gross weight was rated at 41,000 pounds. Today, the Liberator is rated at 60,000 pounds gross with ten to thirteen 50 calibre machine guns operating in four power turrets, with a crew of ten, ten tons of bombs and far greater supplies of fuel and ammunition.

Even with this increase in load, the 56″ tire size that equipped the original Liberator still does the job. Lighter, stronger U.S. Royal Rayon Cords replaced heavier, bulkier cotton cords. And today, more muscle, more strength to carry the thirty-ton load of the Liberator loaded for action are built into the new 56″ "U.S." Nylon tires for the Army Air Forces.

• • •

Listen to the Philharmonic Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 EWT. Carl Van Doren and a guest star present an interlude of historical significance.

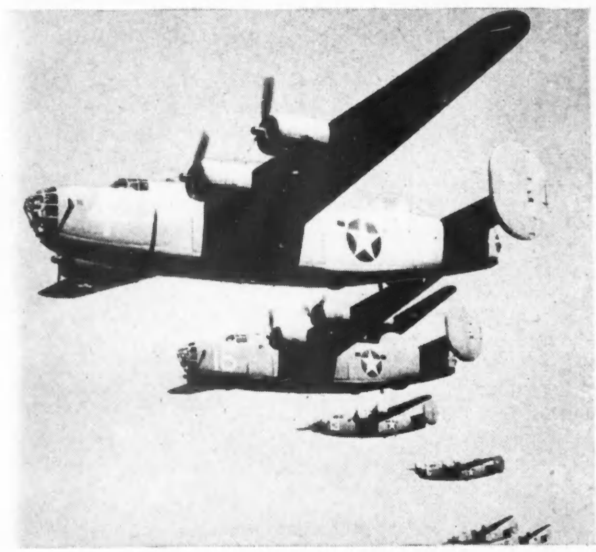
1230 SIXTH AVENUE **UNITED STATES** UNITED STATES RUBBER COMPANY

INCREASED 19,000 POUNDS SINCE 1940

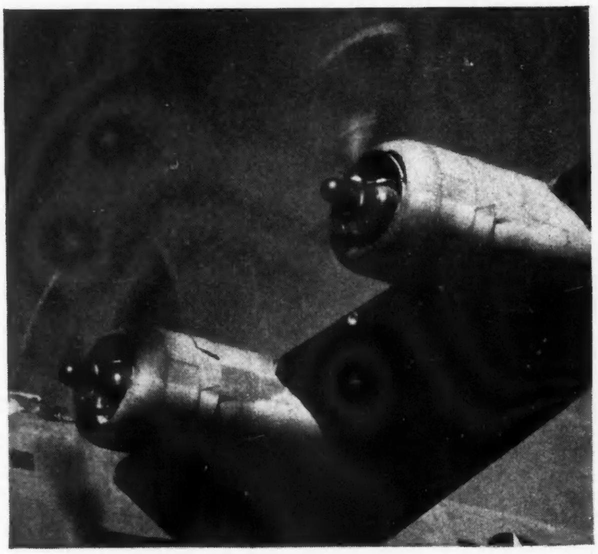
Airplane Tire Carries The Load!

MORE GUNS! When Consolidated introduced the Liberator, its armament consisted of four 30 calibre and three 50 calibre machine guns weighing 460 pounds. Today, the B-24 carries from ten to thirteen 50 calibre guns operating from four power turrets and weighing 900 pounds.

MORE BOMBS! As bombing missions have grown in intensity, the Liberator's bomb loads have increased so that today it carries ten tons of bombs tucked away in its belly to rain block-busting havoc on enemy objectives. Oil fields, railway yards, munitions plants have felt their destructive power.



MORE FUEL! Stored in bullet-sealing fuel cells in the wings and fuselage, the fuel supply of the Liberator gives it extra-long range. Fuel cells built by "U.S." fly with the B-24 in every war theatre—protect the greater gas supply against enemy gunfire.



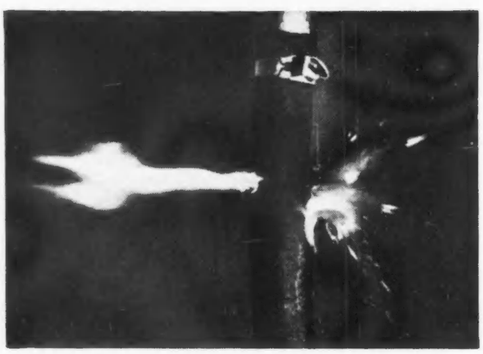
MORE POWER! The four engines of the B-24 of 1940 weighed 9,636 pounds. In 1944 the Liberator power plant including turbosuperchargers weighs 11,572 pounds. "U.S." Tires are lighter and stronger to carry the heavier load.

RUBBER COMPANY ROCKEFELLER CENTER, NEW YORK 20, N.Y.

From Flying Boots to Fuel Cells
...From Boats to Block Tread Tires

FLYING BOOTS...When the altimeter points to 30,000 feet and better, the thermometer goes *way* down. That's when these extra-warm fleece-lined "U.S." Flying Boots really do their job.

LIFESAVING BOATS... Today, every Army and Navy bomber is equipped with inflatable rubber boats, many of them designed and built by United States Rubber Company.



FUEL HOSE... Even when drilled with enemy machine gunfire, this "U.S." Bullet-Sealing Fuel Hose heals the bullet wound, prevents loss of fuel and protects the plane and crew.

FUEL CELLS...Hidden in the wings and fuselage, "U.S."-built bullet-sealing fuel cells protect the gas load of U. S. Army and Navy fighting planes against enemy gunfire.

U. S. ROYAL AIRPLANE TIRES...U.S. Royal Block Tread Airplane Tires take the shock of landing 60,000 pound Liberators and Flying Fortresses on every type of landing strip from emergency steel runway to desert sand.

These are only a few of the many United States Rubber Company products that have been developed with the help and cooperation of the Materiel Command, Army Air Forces and the Technical Staff of the Navy Bureau of Aeronautics. These products, many of them created in "U.S." laboratories, are today serving through science that men may live to build a better world.

SERVING THROUGH SCIENCE

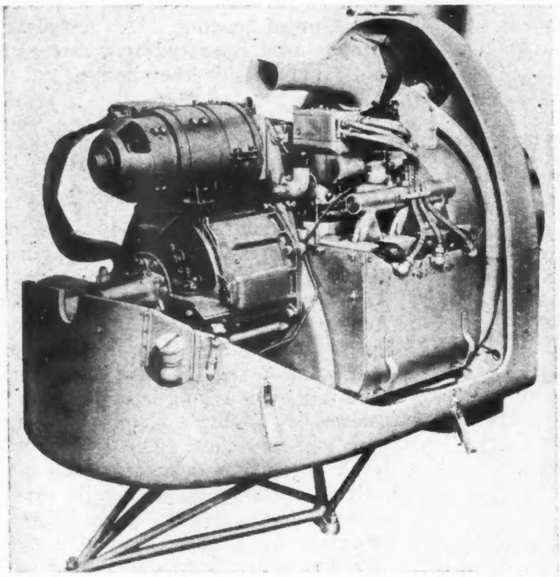
UNITED STATES RUBBER COMPANY

UNITED STATES RUBBER COMPANY · U S · TRADE MARK

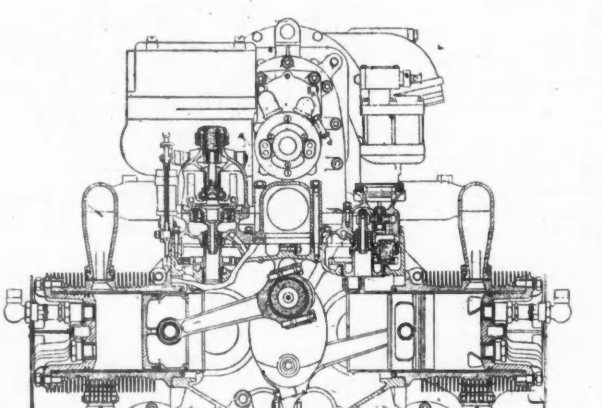
1230 SIXTH AVENUE · ROCKEFELLER CENTER · NEW YORK 20, N. Y.

Aircraft Auxiliary Plant

ROTOL AIRSCREWS, LIMITED, England, whose parent companies are Rolls-Royce and Bristol Aeroplane Co., has introduced in that country what is termed the AGP—auxiliary generating plant. By means of this plant all aircraft services, whether mechanical, electrical, hydraulic or pneumatic, can be operated by independent electric motors located in any convenient position close to their work. The generating plant is intended to be fitted in the hull or fuselage, where it will be readily accessible, and to provide current for engine-starting, operating the undercarriage, flaps, radiator shutters (or cowling louvres), main throttle servo, propeller mechanism, air pumps for navigation, automatic pilot and wheel brakes, lighting, heating, cooking, radio, de-icing, air-conditioning, charging stand-by batteries and any other service, such as turret operation on a military machine.



The AGP unit consists of a gasoline engine driving two electric generators, one a large capacity alternator and the other a small direct current type. The first provides alternating current to drive the various electric motors for heating radiators, cookers, etc., and for starting the main engines, while the second supplies direct current of lower voltage for charging a stand-by battery and excit-



ing the alternator. Actually, for the latter service there is a third generator built in tandem as a unit with the second.

The engine is a six-cylinder horizontally opposed air-cooled unit with magneto ignition, sleeve valves and a bore and stroke of 3.375 by 3.0 in., giving a piston displacement of 161 cu in. It is intended that high octane fuel (87 to 100) shall be used, so a compression ratio of 7.8 to 1 has been adopted. Engine speed is governed to 3750 rpm, almost independent of load. The rated altitude is 12,000 ft and the rated power 60 bhp, though actually the engine develops 93 bhp. Weight of the complete unit (without ducting to the outside of the aircraft and local controls and regulation panels) is 450 lb.

To prevent the escape of fumes into the hull or fuselage the entire AGP unit is enclosed in a housing vented directly to the exterior of the aircraft. The housing, mounted on rubber, is lined with sound-proofing material and the exhaust is effectively silenced.

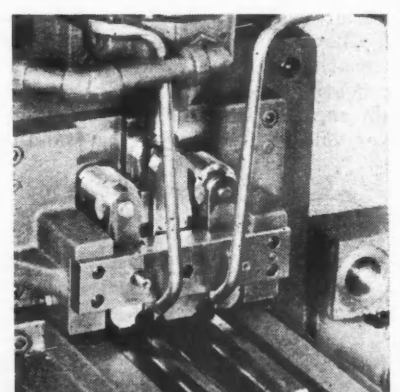
The cylinders are machined from light alloy. The valve sleeves, within which the pistons reciprocate and which closely resemble on a small scale, those of the Bristol radial aircraft engines, are operated by small cranks, giving them a rotary and reciprocating motion.

Pistons are of light alloy and have two pressure and two scraper rings. The connecting rods, of steel, have bronze bushes in the small ends for the floating hollow wrist pins. The six-throw crankshaft is carried in four plain bearings and a large ball bearing close to the alternator rotor, which acts as a flywheel. At the opposite end of the crankshaft is a fan of the blower (multi-blade) type for cooling engine and generators. Lubrication is of the dry sump type. The separate oil tank, with a capacity for 24 hours continuous running, is built into one end of the sound-proof casing. A self-cleaning filter is used, operated by a ratchet control from outside the casing.

Broaching Speeds Output Of Airplane Brake Inserts

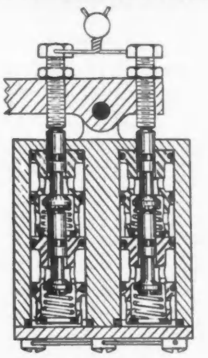
The production of alloy steel drive spline inserts for airplane hydraulic disk brakes has been increased at the Aeronautical Division of the National Acme Co. in Cleveland by using broaching to cut the deep slots in them. More than half of the 13/16 in. dia. stock is removed over a length of 3 in. in two passes by a single machine equipped with two broaches. The set-up, which is shown in the accompanying photo, utilizes a horizontal broaching machine of sufficient capacity to pull the two broaches simultaneously and a special cam and roller fixture designed by the Colonial Broach Co. of Detroit for holding the two pieces rigidly in the correct locating positions.

In the first station the broach produces a flat the length of the piece, removing approximately ¼ in. of the



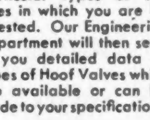
diameter, at the same time leaving about .031 in. of metal to start forming the sides of the slot. In the second pass, the slot is deepened an additional ¼ in. (approximately) and the width not only brought to size but the sides of the slot are highly finished and held within close limits. The top edges of the sides of the slot are also rounded. The production rate for set-up is approximately 100 pieces per hour.

"O" Ring Seal Improves Valve Seating



Hoof is Supplying Many Types of Valves to the Aircraft Industry

Leading manufacturers of military aircraft are being supplied by Hoof with over 20 different types of valves, including Shuttle, Selector, Timing, Thermal Relief, Automatic Shutoff (Fuse). Let us know the particular types of devices in which you are interested. Our Engineering Department will then send to you detailed data on types of Hoof Valves which are available or can be made to your specifications.



This new Check Valve with the "O" Ring Seal was designed by Hoof to provide an extra margin of safety against seating failures, and is now being supplied to leading Military Aircraft Manufacturers. These valves eliminate the risk of leaks resulting from foreign particles being hammered into valve seats (or even if washed away, producing scarred seating surfaces).

The new patented "O" Ring Seal on Hoof Check Valves prevent this—and thus assures a perfect seal. The cushioning effect of the resilient "O" Ring takes up the full shock load—so that foreign particles in the service lines do not become imbedded in the seat, but are automatically washed off the soft "O" Ring material. That this actually happens, has been proven repeatedly in numerous tests*, and in actual use on thousands of aircraft already equipped with these Hoof Check Valves.

No lapping, or wear-in period is required. Leak-proof sealing is obtained immediately. Built to remain leak-proof for the life of the "ship".

The Hoof Check Valve with the "O" Ring Seal is suitable for use with all service lines —hydraulic, gasoline, air, nitrogen, etc. Can be furnished with any combinations of end fittings to suit your particular installation. Write us for sample valve and submit specifications for specific proposals.

These check valves are air-tested for leaks at a minimum of 5 p.s.i. besides the normal hydraulic testing in accordance with the latest Army Air Forces' specifications.

Hoof Products Company

6543 So. Laramie Avenue, Chicago 38, Illinois

NASC Standards

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C

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Cap — Flared Tube Fitting, Plastic NAS243
Cap — Military Control Wheel Hub NAS162
Cap—Rigid Tube or Hose Fitting, Plastic NAS244
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Elbow—Hose and Pipe Thread, 90°, Plastic NAS256
Elbow—Hose, Bulkhead, 45°, Plastic NAS263
Elbow—Hose, Bulkhead, 90°, Plastic NAS257
Elbow — Hose, Flared Tube, Bulkhead and Universal 45°, Plastic NAS261
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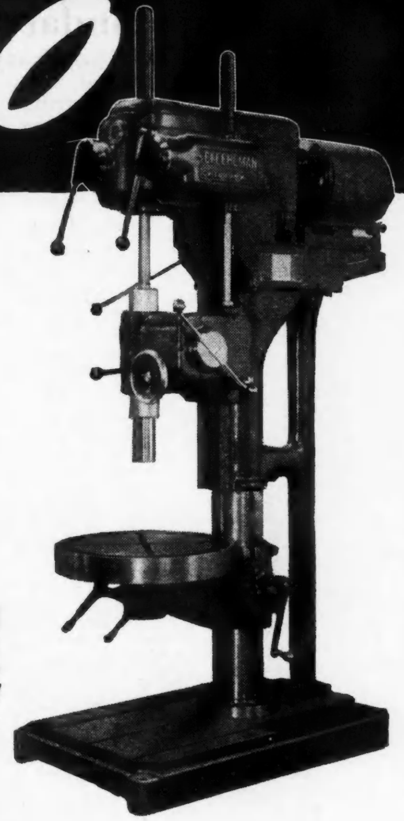
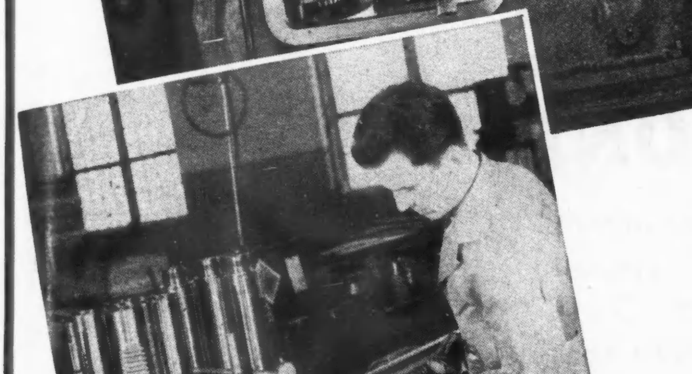
One, or 1000



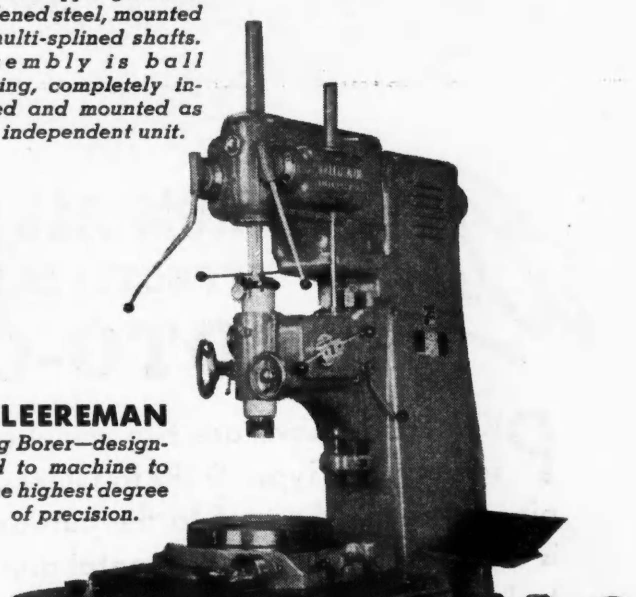
Whether you produce single pieces, or parts in large quantities; or make jigs and fixtures, you will want the efficiency, the precision, the high speed, the adaptability, and the long working life of Cleereman Drilling Machines and Jig Borers.

CLEEREMAN
Sliding Head Drilling Machine—made in Round Column and Box Column Types.

◄CLEEREMAN
Feed Gear Box—sliding selective type gears of hardened steel, mounted on multi-splined shafts. Assembly is ball bearing, completely inclosed and mounted as an independent unit.



Inspecting and assembling spindle and quill for Cleereman Jig Borers.



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Jig Borer—designed to machine to the highest degree of precision.

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NASC Standards

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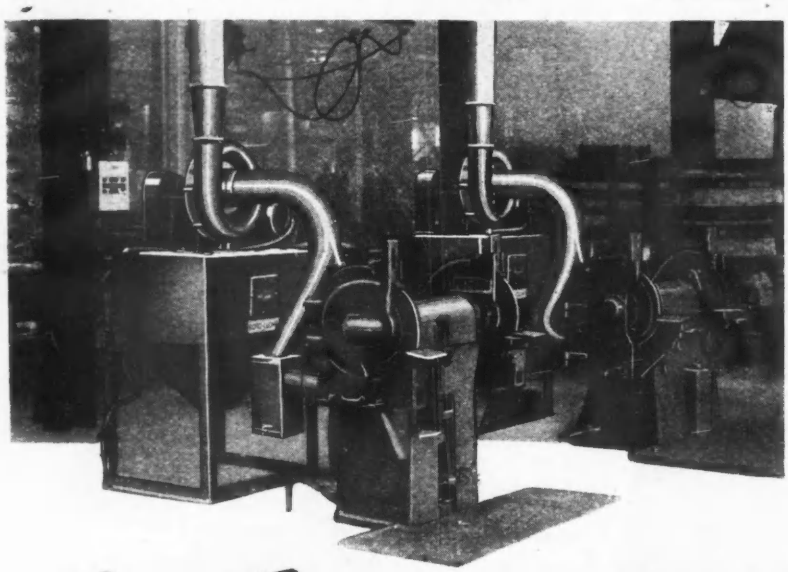

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We are specialists in the manufacture of Hexagon and Drilled Head Bolts, Clevis Bolts and Pins, Clevis Rod Ends, Fillister and Washer Head Screws, Threaded Taper Pins and Washers, and Castellated Nuts. Our organization is keyed to the economical production of these selected specialties only . . . to see that they are made in an efficient manner, of high quality materials and conforming to, or exceeding, standard specifications. Buy from AEROSCREW . . . and be sure of getting good products, well made. Our Catalog gives sizes, engineering data, and list prices . . . write for your copy.

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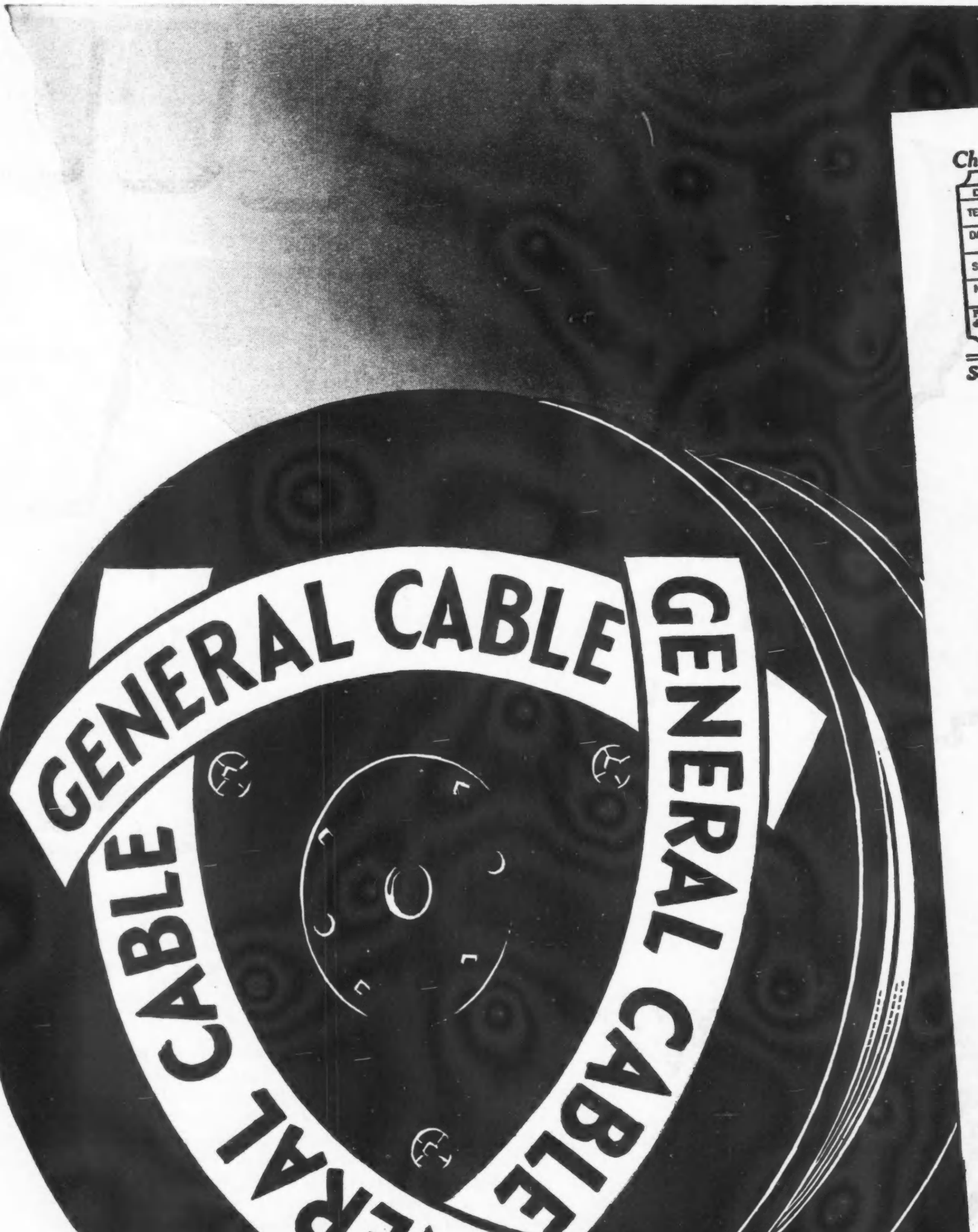

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1944, FEB. 17

TO OUR CUSTOMERS:

CONTINUING OUR SURVEY OF THE PRACTICES, CONDITIONS AND PROCEDURES THAT HAVE BEEN EXISTENT IN THE WIRE AND CABLE INDUSTRY OVER A PERIOD OF YEARS, WE ARE SATISFIED THAT THE ELIMINATION OF SOME OF THESE POLICIES CANNOT HELP BUT RESULT IN SUBSTANTIAL BENEFITS TO ALL BRANCHES OF THE ELECTRICAL INDUSTRY, TO ALL CUSTOMERS AND TO THE GENERAL PUBLIC. AS OUR STUDIES DEVELOP THE NEED FOR CORRECTIVE MEASURES, WE WILL, IN LINE WITH OUR CONSISTENT POLICY, PROMPTLY INSTITUTE SUCH CHANGES AS EXPERIENCE AND CONSIDERED OPINION WARRANT.

AT THIS TIME WE FEEL IT INCUMBENT UPON US TO ASSUME "CLEARANCE OF THE DECKS" IN RESPECT TO REELS, SPOOLS AND CASES WHICH ARE USED FOR THE SHIPMENT OF PRODUCTS OF OUR MANUFACTURE.

EFFECTIVE MARCH 1, ALL GENERAL CABLE CORPORATION CONTAINERS WILL BE SHIPPED ON A "NO CHARGE" BASIS AND NO PAYMENT OR DEPOSIT WILL BE REQUIRED.

WE HAVE CONFIDENCE THAT OPERATION OF THIS PLAN WILL RECEIVE THE SUPPORT AND COOPERATION OF ALL PARTIES AT INTEREST, ELIMINATING AS IT DOES THE PRESENT COSTLY AND MANPOWER-CONSUMING METHOD OF HANDLING CONTAINERS. IT IS REQUESTED THAT ALL GENERAL CABLE CORPORATION RETURNABLE TYPE CONTAINERS BE RETURNED PROMPTLY, FREIGHT COLLECT.

WE WILL ALLOW CREDIT FOR THE RETURN OF ALL CONTAINERS YOU HAVE BEEN BILLED FOR AS CONTAINERS AND WHICH YOU HAVE PAID FOR, PROVIDED THEY ARE RETURNED IN GOOD CONDITION ON OR BEFORE FEBRUARY 28, 1945. AFTER THAT DATE, NO CREDIT WILL BE ALLOWED FOR THE RETURN OF CONTAINERS.

THE COOPERATIVE EFFORT OF ALL CONCERNED WILL DETERMINE THE EFFECTIVENESS OF OUR POLICY AND OF OUR ABILITY TO CONTINUE IT.

GENERAL CABLE CORPORATION....

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BUILDING FOR VICTORY

COMPLEX precision devices such as the RAF bombsight, the Sperry automatic pilot, the .50 caliber Browning machine gun, and the AC aircraft spark plug have been on continuous assembly production at AC for many months. Their quality has been demonstrated at Midway, over Axis Europe, in Africa, and in many other battle areas.

We at AC believe that it was possible to produce these war materials because of the precision manufacturing experience acquired in the 33 years before Pearl Harbor. If we had not known how to make good spark plugs, speedometers, die castings, ammeters, and other automotive devices, we might have had more difficulty getting into war production.

That "know how" is still present at AC.

When peace comes, it will again be at the service of industry.

"VICTORY IS OUR BUSINESS"

Air Cleaners · Air Cleaner Elements · Aircraft Coolant Pressure Relief Valves · Air Pressure Gauges Cable Terminal Connectors · Carbon Stack Insulators · Carburetor Intake Silencers and Air Cleaners Crankcase Breathers · Crankcase Ventilating Valves · Die Castings · Diesel Engine Intake Silencers Electric Pressure and Vacuum Pumps · Engine Bearings · Firing Pins for Anti-Aircraft Shells · Flame Arrestors · Flexible Shafts and Cables · Fuel and Vacuum Pumps · Fuel Pump Repair Kits · Gas Tank Pressure Caps · Gasoline Strainers · Ignition Cable Terminals · Instruments and Panels · Oil Filters Oil Filter Replacement Elements · Oil Temperature Gauges · Oxygen Pressure Gauges · Radiator Pressure Caps · Shell Magazines · Spark Plugs Spark Plug Cleaners · Spark Plug Gapping Tools Speedometer Drive Adapters · Torpedo Directors

Let's ALL BACK THE ATTACK with WAR BONDS

AC SPARK PLUG DIVISION, GENERAL MOTORS CORPORATION

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NASC Standards

(Continued from page 198)

Terminal—Tank Strap, Forked NAS24
Terminal—Tank Strap, Plain .NAS23
Trunnion—Tank Strap, Threaded NAS25
Trunnion — Tank Strap, Unthreaded NAS26
Tube—Control, ⅜ O.D. and ½ O.D., Aluminum Alloy......NAS115
Tube—Control, ⅜ O.D. and ½ O.D. Steel NAS102
Tube, Riveted Assembly, ⅜ O.D., Aluminum Alloy, Threaded Rod Ends........NAS114
Tube, Riveted Assembly, ½ O.D., Aluminum Alloy, Threaded Rod Ends........NAS119
Tube, Welded Assembly, ⅜ O.D., Steel, Clevis and Threaded Rod Ends........NAS97
Tube, Welded Assembly, ⅜ O.D., Steel, Threaded Rod End NAS101
Tube, Welded Assembly, ½ O. D., Steel, ¼ Threaded Rod Ends NAS109
Tube, Welded Assembly, ½ O. D., Steel 5/16 Threaded Rod Ends NAS110
Turnbuckle—Tank Strap NAS27

U

Union—Flared Tube, Bulkhead and Universal, Plastic.....NAS248
Union—Flared Tube, Plastic..NAS246
Union—Hose, Bulkhead, Plastic NAS252
Union — Hose, Flared Tube, Bulkhead and Universal, Plastic NAS250

V

Valve Assembly—Flapper ...NAS11

W

Washers—Plain NAS70
Washers—X-4130 or Equivalent, H. T 125,000 to 145,000 PSI, Countersunk and Plain Types NAS143
Welded Assembly — Tube, ⅜ O.D., Steel, Clevis and Threaded Rod Ends........NAS97
Welded Assembly — Tube, ⅜ O.D., Steel, Threaded Rod Ends NAS101
Welded Assembly — Tube, ½ O.D., Steel, ¼ Threaded Rod Ends NAS109
Welded Assembly — Tube, ½ O. D., Steel, 5/16 Threaded Rod Ends NAS110
Wheel—Control, Pilot's, Military, Aileron NAS160
Wiring Diagram Symbols, Aircraft NAS71

Z

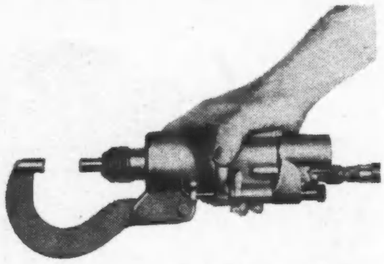
Zees — Equal Legs, Extruded, 24S Aluminum Alloy.......NAS135
Zees—Unequal Legs, Extruded, 24S Aluminum Alloy.......NAS136

New Products for Aircraft

(*Continued from page* 146)

will supply three 12-volt 32 candle-power lamps or six 24-volt 32-candle-power lamps.

Accuracy of the flashing mechanism is maintained by the use of a constant-speed, compound-wound, ball-bearing motor. The motor is mounted directly to the gear-housing. Speed reduction is secured through a grease-packed two-stage worm reduction gear. Adequate filtering is provided to eliminate interference with the radio equipment.



Ingersoll-Rand Air-Buck riveter

As a safety precaution, should the motor slow down or stop, continuous operation of the white light is provided by a double-throw switch. When the motor is operating, the switch is in a position to operate the blinking lights and when the motor stops, the switch is actuated so that the continuous white light operates.

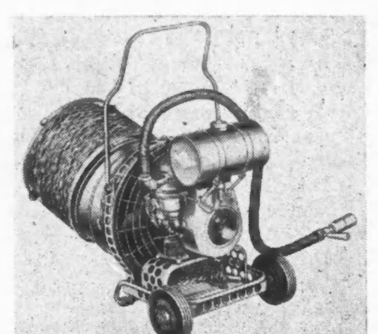
Riveter Requires Only One Operator

The Air-Buck riveter, a product of Ingersoll-Rand Company, Phillipsburg, N. J., does its own bucking up, by means of a yoke, thereby requiring but one operator. It further simplifies the riveting operation by driving the driven head to a predetermined height, which is adjustable, then automatically shutting off when this height is obtained. It is smaller and lighter than squeeze riveters of equal capacity. The two-stage throttle enables the operator to align or inspect the rivet with an initial, partial pressure before driving it home with full pressure.

The "Air-Buck" can be used to advantage wherever aluminum rivets up to 7/16 in. diameter must be driven and where it is possible to use a yoke-type tool. Yokes of different sizes are easily interchanged.

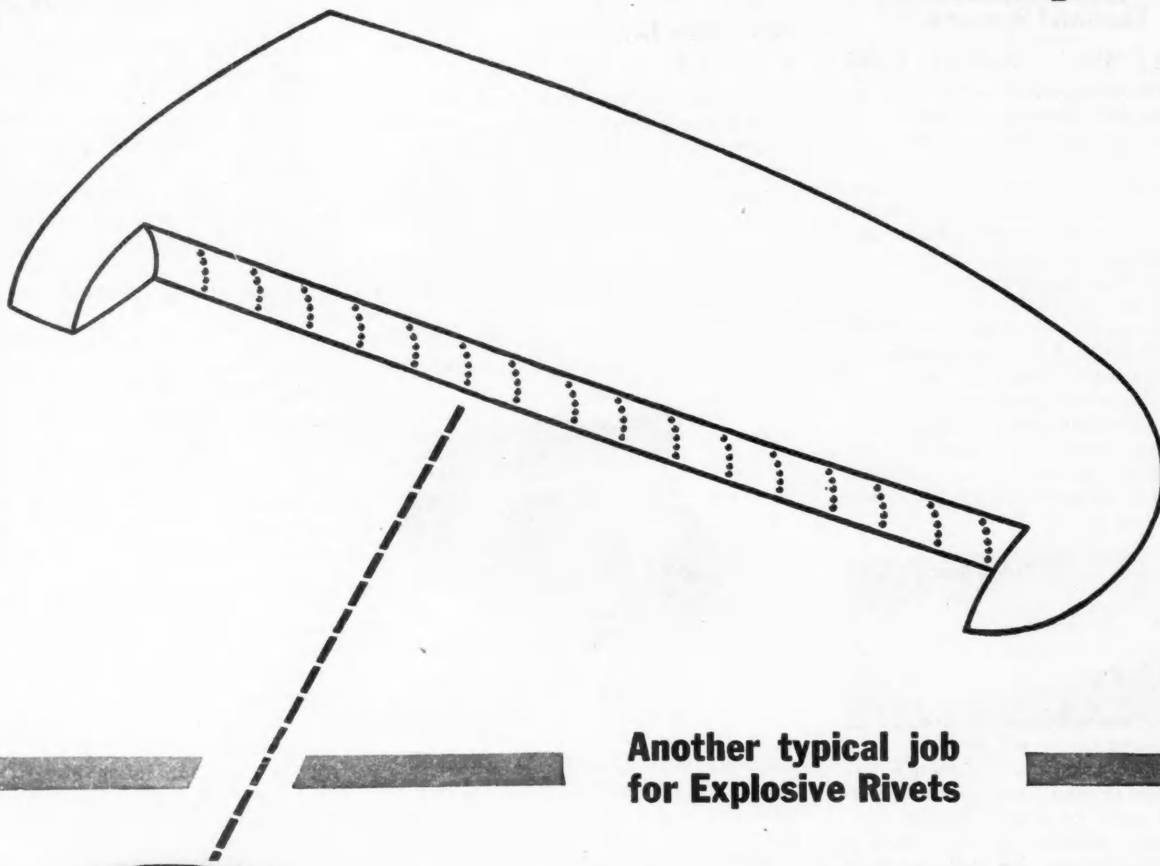
Self-Powered Unit for Portable Ventilation

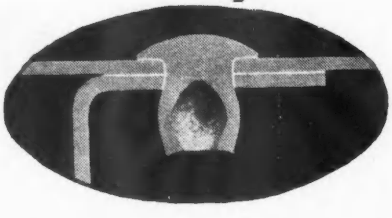
A portable, self-powered ventilator is now in production at The Herman Nelson Corporation, Moline, Ill. Primarily designed for use in cooling the interior of aircraft during repair work in hot climates, several other applications have been evolved by the necessities of war, and many civilian uses are anticipated.

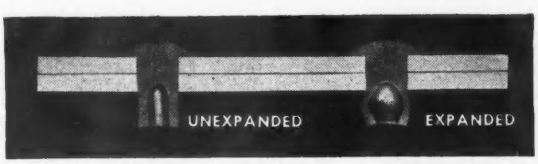


Herman Nelson self-powered ventilator

The unit consists of a Herman Nelson pressure-type fan, driven by a small gasoline engine or electric motor, connected to a collapsible canvas duct through which the air is propelled to the area to be ventilated. Air delivery at 3400 rpm is 4500 cfm without duct assembly attached, and 4000 cfm with duct assembly attached. The whole unit, mounted on wheels, is 24⅝ in. high. Weighing only 87 lbs, it can be






UNEXPANDED
EXPANDED

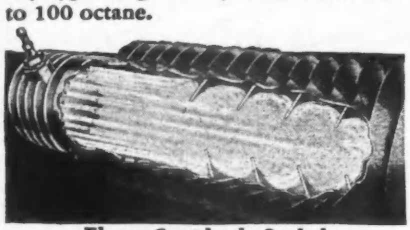
SIMPLICITY OF HUNTER HEATERS BROADENS USES

Engineers Aid Application of Universal Gasoline Burner to Armed Forces and Other Essential Services

FEATURES "SEALED-IN-STEEL" FLAME

CLEVELAND, OHIO—Growing demands for simple and efficient heating for mobile service units, portable housing elements and other special problems has resulted in the setting up of a special division of Hunter and Company of this city. The sub-division will work with designers, builders, purchasers or users of special equipment for the armed forces or for essential civilian services.

Success in the varied uses to which Hunter Heaters already have been applied resulted in this broadening of interest. This has been largely due to the extreme simplicity of the Hunter "Sealed-in-Steel" burner, the fact that it will "give out heat in a big way" from any type of gasoline, from truck fuel to 100 octane.



Flame Completely Sealed

The basic unit is a completely enclosed steel tubular burner, with highly effective areas of heat radiating fins. Atomizing, ignition and combustion take place within the welded steel chamber, the only opening being an exhaust, which can be piped to an outside vent. Hunter units for both heating and ventilation include small, powerful blowers, built into the compact heater casings. Heaters designed for operation from either battery or 110 volt current.

It would be impossible to list all of the uses to which the existing models can be put. Engineers with the armed forces and with companies building equipment are calling every day for applications hitherto undreamed of.

The basic principle is similar to the combustion of an automobile engine —just as simple, safe and sure. Models are made in 25-pound packages putting out 10,000 B.t.u. per hour or in larger models giving any amount of heat required. On heating problems in between or outside of the standard models, Hunter engineers stand ready to work with your engineers in fitting specific needs.

Requests for product information bulletin "HA-2" or for engineering data should be addressed to . . .

Hunter and Company, 1552 East 17th Street, Cleveland, Ohio.

(Advertisement)

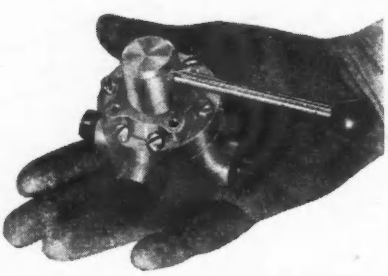
wheeled by one man and lifted into the interior of a plane when it is desirable to use the ventilator without the duct or to ventilate a distant compartment.

In addition to its use on aircraft, where it either blows outdoor air into the plane or exhausts hot air from the interior, the unit has been found useful for drying out the bilges, engine rooms and double bottoms on boats, and for driving out gases and fumes from confined spaces.

Hydraulic Directional Control Valve

Hydraulics, Inc., Pasadena, Cal., announce their newly developed hydraulic directional control valve. This valve, weighing only 13 ounces, is designed to operate under a pressure of 3000 psi with a maximum handle torque of 20 in. lbs.

The valve is of semi-balanced poppet type and is so designed that excessive pressure in the cylinder lines due to thermal expansion of the hydraulic fluid has no effect upon the operation and



Hydraulic control valve made by Hydraulics, Inc.

handle torque of the valve. Likewise, back pressure caused by the valve being partially open does not add to the handle torque.

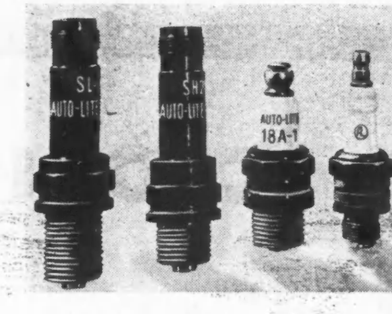
Because of a rotary disc type of cam utilized in the valve, it readily adapts itself to operation by a small electric motor. The electrically driven valve is available for 24-volt, 3-ampere, d-c circuits and 200-volt, 400-cycle, a-c circuits. It is capable of opening in one-half second.

The valve is available in 3-5 gpm and 6-10 gpm sizes with handle torque in both sizes approximately the same. The mounting and porting (either AN or AC) can be to the customer's specifications.

Auto-Lite Spark Plugs for Aircraft

Three new-type spark plugs for aircraft which feature insulators made from ceramic instead of the conventional mica are now being produced by the Electric Auto-Lite Company for Army aircraft.

General improvement in plug operation is said to be gained mostly through development of the new ceramic insulator which, in compression, has a mechanical strength greater than steel,



Auto-Lite aircraft spark plugs

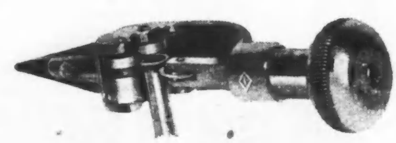
hardness approaching a diamond and a virtual immunity to thermal shock.

The three new designs are suitable for most important Army aircraft applications. Training planes and aircraft without radio installations use an unshielded short-reach plug. Most bombers and all fighter planes use shielded plugs of long reach while the short reach shielded plugs are designed for lower power planes such as advanced trainers.

Tube Cutter With Grooved Rollers

The Imperial Brass Mfg. Co., Chicago, Ill., has brought out a tube cutter for aircraft work, the No. 212-F aviation tube cutter, which is designed to make clean, right angle cuts essential to perfect AN-type flares.

This tool cuts aluminum, aluminum alloy, copper, brass or steel aircraft tubing in sizes from ⅛ in. to 1⅛ in. outside diameter. The tubing rests against two rollers, and a special flare cut-off groove in the rollers enables the operator to remove a damaged flare with a minimum of waste. This flare groove is designed to handle AND-10061 flares on tubing up to 1 in. OD.



Imperial No. 212-F aviation tube cutter

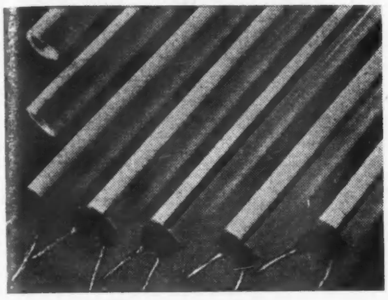
A reamer for removing burrs is a part of the tool. Telescope type, enclosed feed mechanism protects threads against dirt and damage, and over-all length of tool remains the same regardless of size of tubing being cut. Fine feed thread permits gradual application of cutting pressure, protecting against gouging or egg-shaping of tubing.

Plastic Insulating Tubing With Color Identification

To provide insulation for the electrical wiring of airplanes, and at the same time facilitate identification, Lumarith plastic tubing is now extruded with contrasting color identification lines in the body of the tubing.

"Striatube," as it is called, is said

to have unusual dielectric strength and excellent non-oxydizing properties and to be highly resistant to acids, alkalies, oils and greases. It will not deteriorate due to aging or constant exposure to light. It is available in opaque or transparent tubing, in either flexible or rigid form in a variety of sizes, lengths and thicknesses as well as various degrees of flexibility. In all instances the color stripes are an integral

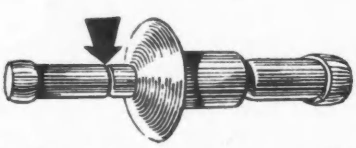


"Straitube" plastic insulation tubes

part of the extrusion and are as permanent as the body of the tubing itself. "Straitube" is a product of Carter Products Corp., Cleveland, Ohio, Lumarith is produced by the Celanese Celluloid Corp., New York, N. Y.

Notch Feature Improves Cherry Blind Rivets

A new feature has been added to Cherry blind rivets by the Cherry Rivet Company, Los Angeles, Cal. A notch in the pulling mandril of the rivet pro-



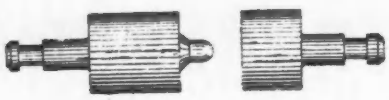
Cherry rivet, showing notch in mandril

vides several advantages. It inhibits the flow of metal in the upsetting process employed in forming the pulling head, resulting in more uniform rivets. Another advantage is that a shorter mandril is required, which saves material and provides for a shorter drawbolt movement. The shorter movement of the drawbolt makes possible the use of the gun for longer grip lengths.

Standard drilling and dimpling tools are used to apply Cherry rivets. The only tool required is the gun which is used to pull the mandril of the rivet with sufficient force to head the rivet on the blind side and break the stem at the notched portion.

Topflight Two Piece Dimpler

The Topflight two piece dimpler, marketed by the Topflight Tool Com-



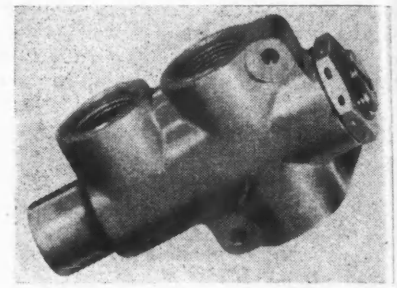
Topflight dimpler

pany, Towson, Md., is designed especially for skin and rib dimpling. The male punch, made in one piece, requires no adjusting. Each tool is said to be individually developed to eliminate cracks. The curved mating surfaces overcome the springback tendencies of dimpled surfaces giving a flat support for skins. Dimpler is designed to coin metal into dimples that nest above or below other sheets of any thickness.

The tool is small, requiring a minimum of effort to position portable squeezer for dimpling in pre-sub assembled wings and frames.

Adjustable Pressure Relief Valves

Adjustable pressure relief valves, VR Type, designed by American Screw Products, Los Angeles, Cal., are said to be particularly adapted for high pressure hydraulic systems in aircraft where smooth operation and long life at maximum flow are necessary characteristics. The valve body is an aluminum forging with an inner casing of stainless steel. The manufacturer claims that the dashpot insures smooth operation and eliminates all vibration

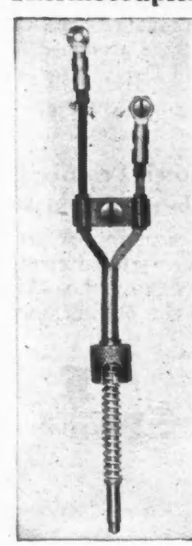


VR Type adjustable pressure relief valve

and chattering when the pressure is balanced against the spring. These new VR Type adjustable pressure relief valves are available in three sizes.

Embedded Type Thermocouples

The Revere Company, Wallingford, Conn., offers an insertion type cylinder head thermocouple which may be used to determine any local condition of overheating. The thermocouples are available as individual units or any number woven as an integral part of a harness.



U. S. Rubber Organizes New Sales Department

With the establishment of a Gillette tire division by the United States Rubber Company on January 1, 1944, a field sales organization responsible only for Gillette sales and distribution has been organized according to Walter D. Baldwin, sales manager of the division.

Advertising Notes

With the admission of Dr. Lyndon O. Brown as a partner, the firm of Paul W. Stewart & Associates, of New York, marketing and distribution consultants, changed its name to Stewart, Brown & Associates on March 1, 1944.

David W. Stotter, copy and account executive for MacFarland, Aveyard & Company, of Chicago, has been promoted to vice-president and copy chief.

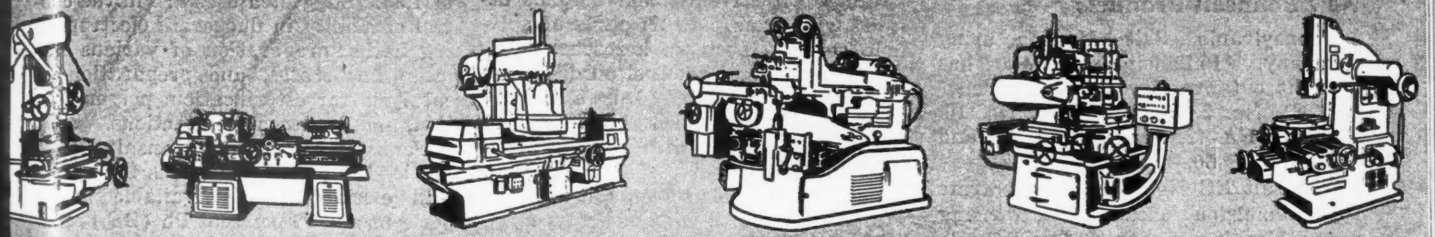
MIDWEST Aircraft Products is ready to meet all delivery requests for the Type AC 37D6210 Oil Dilution Solenoid Valve . . . including latest change. Specialization in this type of valve and adequate plant facilities make this prompt wartime service possible. Ability to produce and change to meet latest aircraft demands is one of the reasons why Midwest Oil Dilution Solenoid Valves are used by most of the leading aircraft manufacturers in the United States and Canada. Inquiries invited.

Let's all buy MORE War Bonds and Stamps

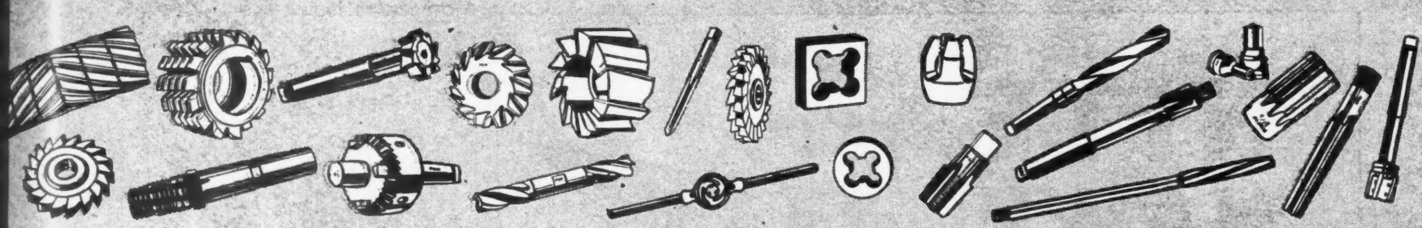
M.A.P.
MIDWEST AIRCRAFT PRODUCTS

MIDWEST AIRCRAFT PRODUCTS, Inc.
DAYTON, OHIO - *Birthplace of the Airplane*

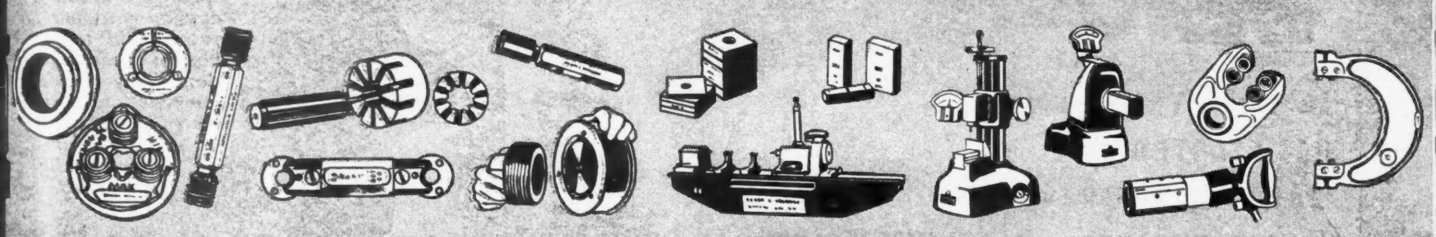
& WHITNEY *reports to Industry*



WITH THOUSANDS OF MACHINES THAT MAKE MACHINES



WITH HUNDREDS OF THOUSANDS OF SMALL TOOLS



WITH CARLOADS OF GAGES AND BASIC MEASURING EQUIPMENT

WARS are not new to Pratt & Whitney. During the past eighty-three years we've served faithfully thru *many* wars . . . delivered to American and Allied industry the kind of goods from which victory has been shaped.

In the present war — from its very beginning — our machines, small tools, and gages have been sought after. We've met that demand in full — with a production record far greater than ever before. During 1942 we produced over FIVE TIMES our best normal peacetime level. In 1943, just passed, we bettered even that. But this record was not achieved by hurrying. You cannot rush Accuracy — not the kind of accuracy that is the bloodstream of the Pratt & Whitney organization. We have enlarged our facilities several times, added and trained new thousands of workers. But thru it all we have held tenaciously to the well-known Pratt & Whitney standard of highest precision workmanship and top quality. The war-time performance of our products has proved this true over and over again.

We didn't have to convert to war — we simply had to make "more of the same thing"— so today, our organization is larger and better trained than ever — ready to carry on to ultimate victory — and into the peacetime years ahead.

PRATT & WHITNEY

Division Niles-Bement-Pond Company

WEST HARTFORD, CONNECTICUT, U.S.A.

New Products

(*Continued from page* 150)

New Pennsalt Products

Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., has brought out five new products: Pennsalt EC No. 2, Pennsalt E.C. No. 10, Pennsalt FA 42, Pennsalt LF 42, and Pennsalt LF 50.

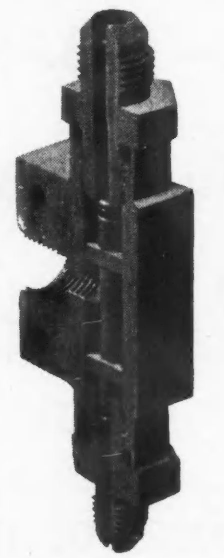
Pennsalt EC No. 2 is a concentrate type emulsion cleaner, comprising soaps, blending agents, and co-solvents for industrial grease cleaning applications. It is soluble in water and in hydrocarbon solvents, and may be diluted with from 5 to 20 parts of suitable solvents such as kerosene, Stoddard solvent, or light fuel oil distillate.

Pennsalt E.C. No. 10 is a solvent emulsion cleaner which combines soap emulsifying action with solvent penetration. Composed of emulsifying agents and suitable solvents, it is of the self-emulsifying, non-phenolic type.

Fluoboric acid, HBF_4, is sold under the trade name "Pennsalt FA 42" as a 42 per cent solution containing a slight excess of boric acid for stabilization. Known also as borofluoric acid and borohydrofluoric acid, it is a clear, colorless solution, having a specific gravity of 1.33. Suggested uses are in the control of acidity in fluoborate electroplating baths, preparation of various metallic fluoborates, and preparation of catalysts for esterification, polymerization, and condensative reactions.

Pennsalt LF 42 and Pennsalt LF 50 are lead fluoborate solutions for use in lead electroplating. Available in 42 per cent and 50 per cent $Pb(BF_4)_2$ concentrations, these solutions are stabilized with excess fluoboric acid (HBF_4), and boric acid (H_3BO_3), in balanced percentages. For use, they are diluted with water to the desired concentration.

Shuttle Valve Features Simplicity



The Electrol Shuttle Valve, a product of Electrol, Inc., Kingston, N. Y., has no springs and only one moving part, yet is said to be positive in operation. This simple construction eliminates the need for grinding, honing, or seating the valve.

Plastic Filter Transmits Ultra-Violet Rays

A plastic filter which transmits ultra-violet light rays from a visible white light fluorescent lamp, and filters out the visible light, has been developed by the Lyon Manufacturing Corp., Chicago, Ill.

The plastic filter can be used with any size fluorescent tubular style lamp or circular type, contemplated for production. It is also available for the two and four watt RP 12 fluorescent airplane lamps and 4 watt T5 six inch lamp. This filter and lamp combination producing the required black light effects cost a fraction of the present source of black light as produced with mercury vapor or carbon arc lamps.

Write Letters to the Boys in the Services

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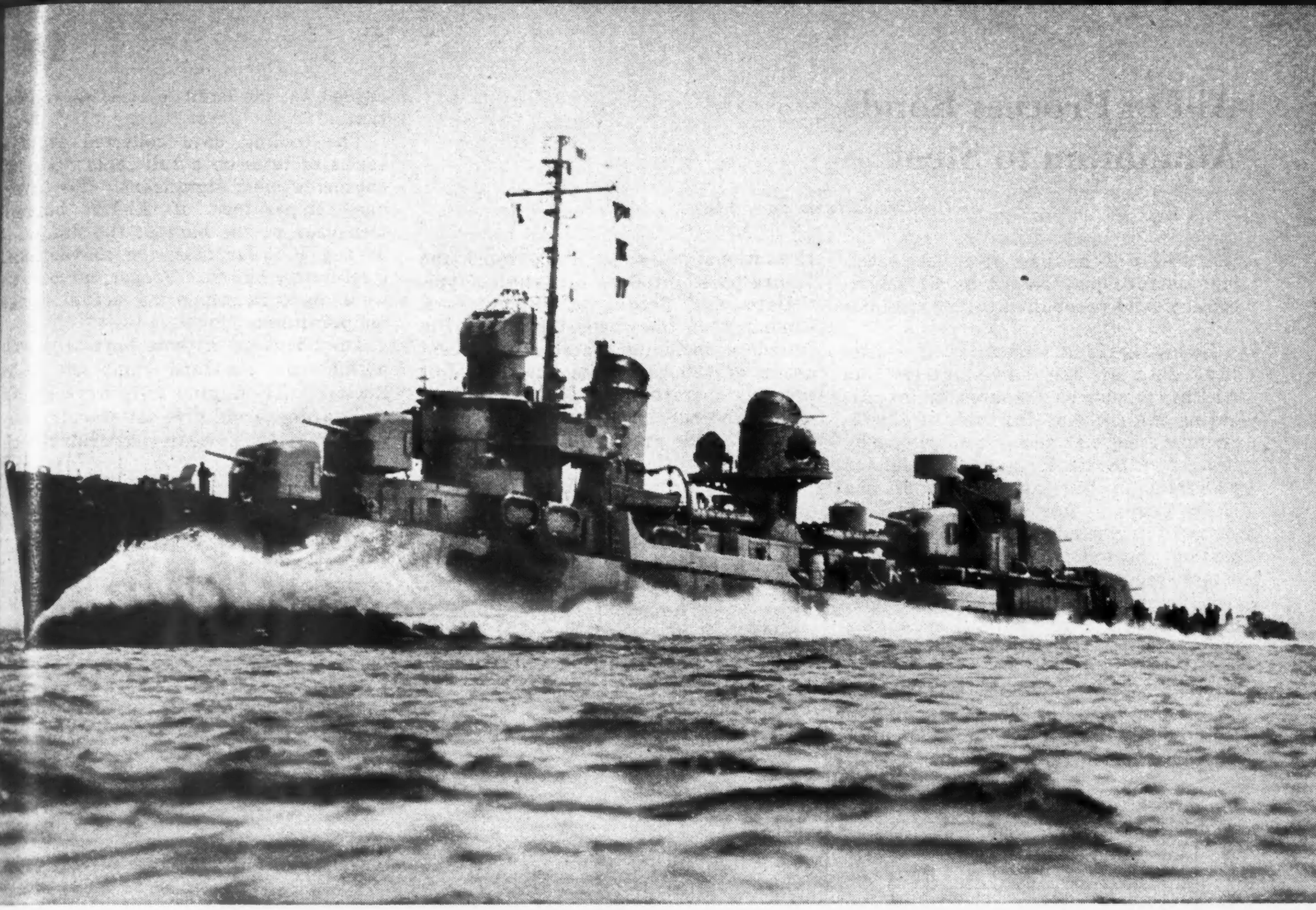


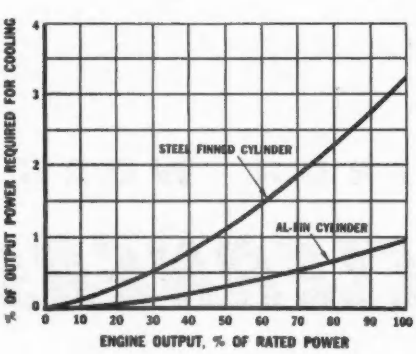
Al-Fin Process Bonds Aluminum to Steel

(*Continued from page* 148)

the Al-Fin bond has given an excellent performance record in all single-cylinder and production engine installations.

Following is a summary of statistical data on the advantage of the Al-Fin cylinder as prepared by investigating engineers on the basis of single-cylinder engine tests conducted by Ranger Aircraft Engines Division of Fairchild in the laboratories of the Ethyl Corp. After six months of investigation, including 340 hours of operation, the following conclusions were established:

1. To maintain a given barrel temperature at a given output, an engine provided with aluminum fins (Al-Fin) uses approximately 37 per cent of the drop of pressure, 55 per cent of the quantity of air, and 22 per cent of the cooling air horsepower, as compared with a conventional steel-finned barrel.



Power required for cooling steel and Al-Fin cylinders.

2. Under given cooling conditions (drop of pressure across the baffles and cooling air temperature) required by an Al-Fin barrel, a steel-finned barrel is capable of less than half the power output of the Al-Fin barrel. Theoretically then, the power output of an engine with steel-finned barrels could be doubled by using Al-Fin barrels without varying the cooling requirements, providing the cylinder heads had the necessary cooling capacity.

3. At equal cooling and operating conditions an Al-Fin barrel engine operates at an average barrel temperature (50 deg F) lower than that of a steel barrel engine. (On the basis of single-cylinder tests.)

4. During experiments no failure of the bond between steel and aluminum was detected on an Al-Fin barrel after 85 hours of operation at power outputs ranging from normal to 140 per cent of normal.

The use of Al-Fin barrels so improves the performance of the Ranger SGV-770 12-cylinder aircooled inline engine that it can almost be called a revolutionary change in the trend and future possibilities of this engine type.

Data On Production Barrels — A summary of the properties of Al-Fin cylinders including data on a recent group of 150 barrels is now available covering operating characteristics, complete physical properties, and design data. Of this group only one was discarded in the muff processing operation.

The cooling data collected from a series of tests on a full scale SGV-770 engine is most significant. The average temperature of Al-Fin barrels, measured at the base of the flange, is 30 deg F lower than the conventional steel-finned barrel. Proper corrections were made in computing actual flange temperatures.

The hardness of these barrels is well within the standard limit of 29-34 Rockwell C. Engine tests have shown this hardness will give satisfactory service as regards wear, particularly on

the higher powered 12-cylinder engines where this has been a very important factor.

The bond currently developed in Al-Fin barrels is greatly improved over that accomplished in early experiments. Its thickness has been reduced to .0005-.00075 in. as compared to a former thickness of approximately .004 in. This means greater strength in tension and practically complete elimination of the fringe or notch type of penetration of the steel base. It now has a tensile strength of approximately 6000 psi. The thermal resistivity of the bond has been determined at two temperature levels, 188 F and 305 F. No effective temperature drop was indicated through the joint.

Fatigue—The fatigue strength of AMS 6382 steel (barrel stock) has been determined under three conditions: (1) Treated by Al-Fin process—54,000 psi; (2) Treated by Al-Fin process and machined to bare steel beneath the coating—71,000 psi; (3) Standard steel samples of normal treatment and condition—70,500 psi.

The high speed of R. R. Moore fatigue machines were used for these tests, require extremely accurate alignment and while every precaution was taken to eliminate distortion in the samples with the aluminum surface, these samples are subject to more of an error than are the all-steel surfaced samples. In other words, this would tend to lower the value of fatigue strength of the coated samples and give a greater spread of points at the endurance limit. The loss of 23 per cent in fatigue strength shown is believed partially due to this effect. When evaluating and interpreting fatigue values which have been obtained, it is important to consider the type of stress imposed on the engine barrel, since our test data are based on rotating beam loading (reverse bending), whereas the barrel proper is subject only to a substantial amount of axial stress.

Swanger and France, A.S.T.M., Volume 32, in testing alloyed coatings with physical characteristics similar to our own, have found that alternating axial stress tests do not show the same strength decreases as shown by rotating beam tests. Using their figures and data, it is indicated that a bonded surface which shows a reduction in endurance limit of 23 per cent on rotating beam fatigue test would show only a reduction of 13.5 per cent under axial loading. In addition, full-scale engine test experience demonstrates loss in fatigue strength to be less than that indicated by rotating beam tests. Al-Fin cylinders have been tested successfully with decreased wall sections where such sections in steel-finned barrels resulted in fatigue failure. Therefore, the picture with respect to fatigue strength of Al-Fin barrels is considerably better than the results of the R. R. Moore beam test would indicate.

Production Cost—The cost of producing Al-Fin cylinder barrels for Ranger engines has been analyzed in view of current practice. It is conservatively estimated that an over-all saving of approximately 20 per cent can be expected over conventional steel-finned types.

Ramsey Offers Training Film

The Ramsey Accessories Manufacturing Corporation of St. Louis, Missouri, announces the completion of a training film "Installation, maintenance and service of Air Craft Pistons and Piston Rings." This film was produced at Wright Field under the supervision and direction of the Army Air Force technicians, and has been adopted by them as their official training film for the subjects covered.

The film is being made available to aircraft engine manufacturers, airlines, training schools or other concerns engaged in educational activities on aircraft engines. It is a 16 millimeter film with sound strip attached, 3471 feet long and runs approximately 40 minutes.

This film will be loaned to reputable companies for educational purposes for a ten-day period on a no-charge basis.

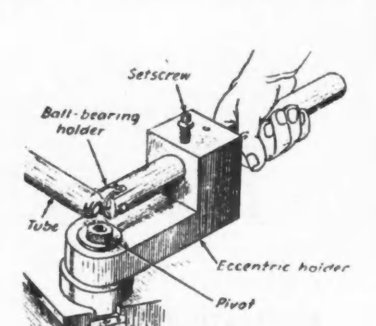
Sawdust Used As Oil Remover

Sawdust as a cleaning compound for removing dirt and oil from aircraft parts after magnetic inspection, and prior to organic or inorganic treatment, is saving man-hours and critical materials at the Los Angeles, Cal., and DeKalb, Ill., plants of the Interstate Aircraft and Engineering Corp. The new sawdust method, developed by Paul Lamb and Horace Maxfield of the Los Angeles plant, is inexpensive and easy to install and operate. By tumbling or rolling the part in a dry sawdust, the excess dirt and oil from all magnafluxed parts is removed. The sawdust adhering to the part is blown off easily by a sharp blast from an air hose, leaving a thin film of oil to protect the part from corrosion.

The action of the sawdust in soaking up the excess oil and dirt left by the magnafluxing minimizes the amount of cleaning required by the usual method of dipping, washing, heating, wiping, etc., in such solutions as carbon tetrachloride, ethylene dichloride, or hot alkaline washes. A reduction in the quantity of cleaning material is also effected by this new process since the excess oil residue from continuous dipping and washing contaminates the cleaning bath and forces frequent renewals of the solution. With the new sawdust method, there is a resultant thin film of oil left on the part which protects it until final plating or painting. This is vitally important since any lengthy delay between cleaning and the coating process allows corrosion to set in.

Tool for Spinning Aluminum Tubing Ends

At Fleetwings, Division of Kaiser Cargo Inc., the production tool shown here was developed for use with a turret lathe to spin aluminum tubing ends. It is made of cold rolled steel and is adjustable by means of the clamping

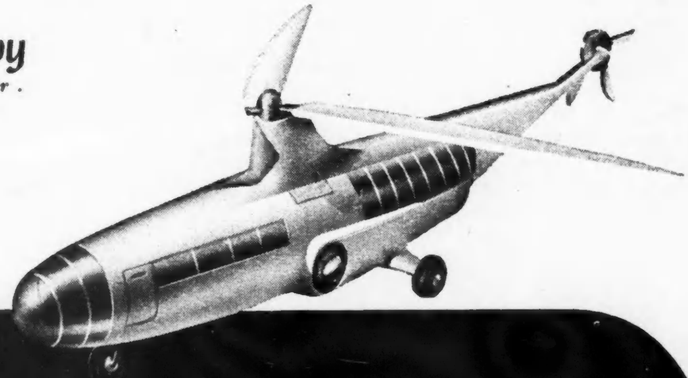


screw, which permits the tool to be set at the desired radius. The spinning roll is a free spinning wheel on ball bearings. The tubing can be inserted from the rear with the lathe set for cutting the small pieces to the required lengths after spinning the end.

I PREDICT...

by Raymond Loewy

Noted Industrial Designer .



After the war you will travel more than you ever have. And one of the developments that will make it possible is the new helicopter air bus. This remarkable aeronautical achievement ushers in a really new mode of transportation that will enable you to make short air trips quickly, inexpensively and in complete comfort. Present bus terminals will be adapted as landing ports and maintenance hangars so you will take off and arrive in central sections of cities and towns. The multi-passenger helicopter air bus, already endorsed by authorities as entirely practical, will bring air travel to millions of persons and thousands of communities that now lack this form of transportation. When you buy War Bonds today remember they will enable you to experience this and many other marvels in tomorrow's world!

* * *

Note: The Weatherhead Company, one of the oldest and most important manufacturers of parts for the aviation industry, is prepared for the day when its four plants will again be contributing to aviation's peacetime needs.

Look Ahead with W

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND, OHIO

Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Plants: Cleveland, Columbia City, Ind., Los Angeles
Canada—St. Thomas, Ontario

***FREE:** Write on company letterhead for "Seeds Of Industry"—a history of The Weatherhead Company, its many facilities and diversified products.*

SAE Standards

(Continued from page 125)

F

Fairing, De-Icer Attachment	AS	74
Flange, Tube — Two Bolt Type—Aircraft Engine	AS	70

G

Generator Envelope (Auxiliary Engine Driven) Mounting Pad and Drive, 8-inch Bolt Circle	*ARP	71
Generator, Mounting Pad and Drive	AS	45A
Generator Mounting Pad and Drive, 4-bolt	*AS	46
Governor, Propeller, Mounting Pad and Drive	AS	43
Gun Synchronizer, Mounting Pad and Drive	*AS	48A

H

Heater Airplane, Exhaust Hot Air Type	ARP	86
Heaters, Airplane, Internal Combustion Type	ARP	143
Heater Airplane, Liquid Type	*ARP	88
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Heating and Ventilating Equipment, Airplane—General Requirements For	ARP	85A
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I

Ignition Shielding, Aircraft	AS	29
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L

Lockwire, Stainless Steel—Aircraft Engine	AS	38

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Mounting Flange, Pad and Drive—Accessory to Gear Box, 10 Inch Bolt Circle	*ARP	72

N

Nomenclature, Aircraft Ice Elimination Equipment	ARP	148
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Nuts, Plain Hexagon—Aircraft Engine	AS	33
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O

Overhaul Manuals for Aircraft Engines	AS	165

P

Pads, Oil Inlet and Outlet, for Airplane Connections Types I, II, III	AS	131
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Performance Presentation, Aircraft Engine—Single Speed Engine	AS	16
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Plug, Dehydrator—Crankcase	AS	8
Plug, Dehydrator — Cylinder	AS	7A
Power Take-Off, Mounting Pad and Drive, Types I and II	AS	53A

(Turn to page 218, please)

HANSEN
PUSH-TITE
HOSE CLAMP SOCKETS
on the Firing Line
Action speaks louder than promises and when you see Hansen PUSH-TITE hose clamp sockets in actual operation you can readily understand why they are indispensable in any plant. For instance, they make an air tool perform better because they feed it air smoothly and at constant steady pressures without any drop due to leaks. A careless operator cannot waste air because Hansen PUSH-TITE Sockets take care of that by automatically turning air on when connected and in use and automatically turning it off when not in use, a big saving in dollars and cents. Can be used on air, oil and grease lines. Leakproof and by that we mean from a two ounce pressure to over 10,000 pounds. To operate—a slight push of plug into socket it is connected, air automatically turned on —easy pull on sleeve it is disconnected, air is automatically turned off.
The hose clamp can be installed by anyone in a few minutes, requires no special tools and can be used many times over. It has two grips—one on inside of hose, one on outside, a 2 to 1 advantage. Hansen PUSH-TITE hose clamp sockets are used by some of the largest plants in the world, where production records are being made almost daily.
HANSEN MANUFACTURING COMPANY
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CLEVELAND
OHIO
Send for Free
Industrial Catalog

SAE Standards

(*Continued from page 216*)

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Propeller Blades, Aluminum Alloy, Shank Dimensions for	AS	90
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Pump, Vacuum or Hydraulic, Mounting Pad & Drive Type I	*AS	49A
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Q

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S

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W

Washers, Plain — Aircraft Engine	AS	36

* New or revised Aeronautical Standards issued as of February 1, 1944.


FOR VICTORY
BUY
UNITED
STATES
WAR
BONDS
AND
STAMPS

GIANT

and JEEP

● Almost lost against the ponderous bulk of the M-25 retriever and the tank it's bringing in, is an Army jeep —weighing about 1 ton as against the massive M-25's 80 tons. Ross Cam and Lever Steering is used on this jeep, just as it is on the M-25 —which is said to be the heaviest of all motor vehicles operating on rubber tires. Large or small—Ross is ready to steer them all and do a top-flight job. Ross has what it takes.

When Allied tanks get into trouble on any war front, the mighty M-25 tank retriever goes and gets them—and brings them back to be repaired —to live and fight again.

Fully loaded, M-25 weighs 80 tons. Here's a steering job beyond the strength of any one man. Ross and Bendix engineers developed the Ross-Bendix Hydraulic Powered Steering Gear unit which solves this difficult steering problem.

Ross

STEERS BOTH!

Photograph supplied by Pacific Car & Foundry Co.

Airbriefs

By Henry Lowe Brownback

YOU cannot have motoring without good roads nor can you have boating without harbors. The same thing holds good for the airplane and the day when a cow-pasture on a hillside with trees, telephone and light wires strung all about it and a tumbledown sheet iron structure in the middle of it with some aviation "dope" painted upon it has gone by. Everyone interested in aviation must start to work now to have some postwar plan for the location of airports for private planes near the centers of population. If they are not laid out and built most of you people getting a living out of aviation today will be doing something else after the war.

Most airports now built will be crowded with commercial traffic and they certainly are not going to mix the two. Further, getting to present day airports from any center of population is often like taking a tour of that part of the country.

What happens to a one airport city when an emergency strikes can be seen in Philadelphia where we have the sorry spectacle of the third largest city in the country aeronautically a suburb of a small city located over 50 miles away.

Future Again

I may be all wrong but I cannot help but feel that the future American family plane must be an amphibian and that anything else can only fill a limited place in the scheme of things. If one lives near a city and wants to go to a lake in the woods he must be able to land on the lake and not 50 miles away. Otherwise he will take the family car instead of the plane. I live in a town located on what the coal mines have left of a very beautiful river and that river is just three minutes walk from the house. If I had an amphibian I could walk to the river, take off and fly to any of the lakes in the Poconos of Pennsylvania or to a yacht club at the seashore and be right in the heart of things. If I had a land plane I would have to drive to an airport and store my car there, then take off and fly to the airport nearest the shore which would mean a long taxi ride or, if I went to my place in Maine, a 40-mile bus ride, so I just don't fly on my little trips.

Private Planes

The private plane, if it is to be flown by "Everyman," has to land slowly. Today planes which land slowly handle badly in stiff breezes when they are near the ground or in puffy wind. They also have a tendency to float badly on landings especially if it is windy and the landing of revolving wing aircraft in a puffy wind requires special skill. Research that will result in the design-

ing of an aircraft inherently stable to a large degree which lands slowly but handles well in bad weather will pay big dividends if it brings success. I think that several foreign engineers whom I have known have been so near the answer that some additional work on their basic ideas will produce the result.

Engines

A few weeks ago I visited a plant where the Vice-President of Engineering told me that he reads *Airbriefs* regularly although he disagrees with them at times. That is natural and I hope that those of you who do disagree write and tell me why. It may start a line of thought which I can pass along and be helpful. I have seen many engines made for aircraft during my 31 years association with the industry. Gasoline, steam, Diesel and jet.

Before the beginning of the current war it was rather freely predicted that any future war would see the end of the gasoline engine. The fact is that the run of this war has just about seen the end of everything else, but I do believe that the gas turbine for higher powers is not far off. Just five years ago I saw some Brown Bovieri gas turbines running at the "Houdry System" plant of the Sun Oil Co. and they are still running. This same system has been applied to turbine locomotives in Switzerland, where the Brown Bovieri plant is located, and there is every reason to believe that the aircraft type is getting very "hot." The B-B combustion chamber is not unlike that used in the jet propulsion systems and it will be interesting to see whether the direct jet reaction or "rocket" action of the expanding gases can be as efficient as when used in connection with a turbine and a propeller. In large power plants the use of gas turbines would result in simplicity in the power plant itself as well as a great decrease in noise and vibration.

Before I left France I was shown a turbine in which the propeller and turbine were combined by feeding high pressure gas through a hollow shaft and propeller blades with orifices in the trailing edge. The inventor hoped that the idea would combine a simple power unit with a frost and ice proof propeller.

Tire Blowouts

A recent issue of a popular photographic magazine shows a fire resulting from a tire blowout on a take-off resulting in the propeller of one engine contacting the ground and tearing the engine out of its mounting. Postwar large planes should have some safety system in the landing gear or tires which would make such an occurrence impossible. As I have said many times, I believe that the large passenger and freight planes of the future will have some sort of a take-off track or catapult instead of depending upon the plane's propellers to build up the necessary speed through their range of least efficiency. When the Wright Brothers envisaged their airlane they took this into account and got their ship off with very little engine power using their pylon and weight, and the very low speed large diameter propellers which produced a maximum of thrust. Later when it became necessary for the airplane to fly out of "fields" the present landing gear system became the vogue, but as it grows up there is little sense in following that vogue, making the wheels and tires larger and larger trying to keep up with increased loadings. Not only can a blowout raise considerable havoc, but such landing gears are plagued with shimmy and other troubles not unknown to the motorist.

Aviation has advanced from the day when the prime requisites for a mechanic were the ability to safety wire things properly and to be able to do a good job of winding rubber shock cord.

The North Pole

Little did Admiral Peary think, as he dragged out mile after mile in misery over the frozen Arctic wastes,

(*Turn to page 228, please*)

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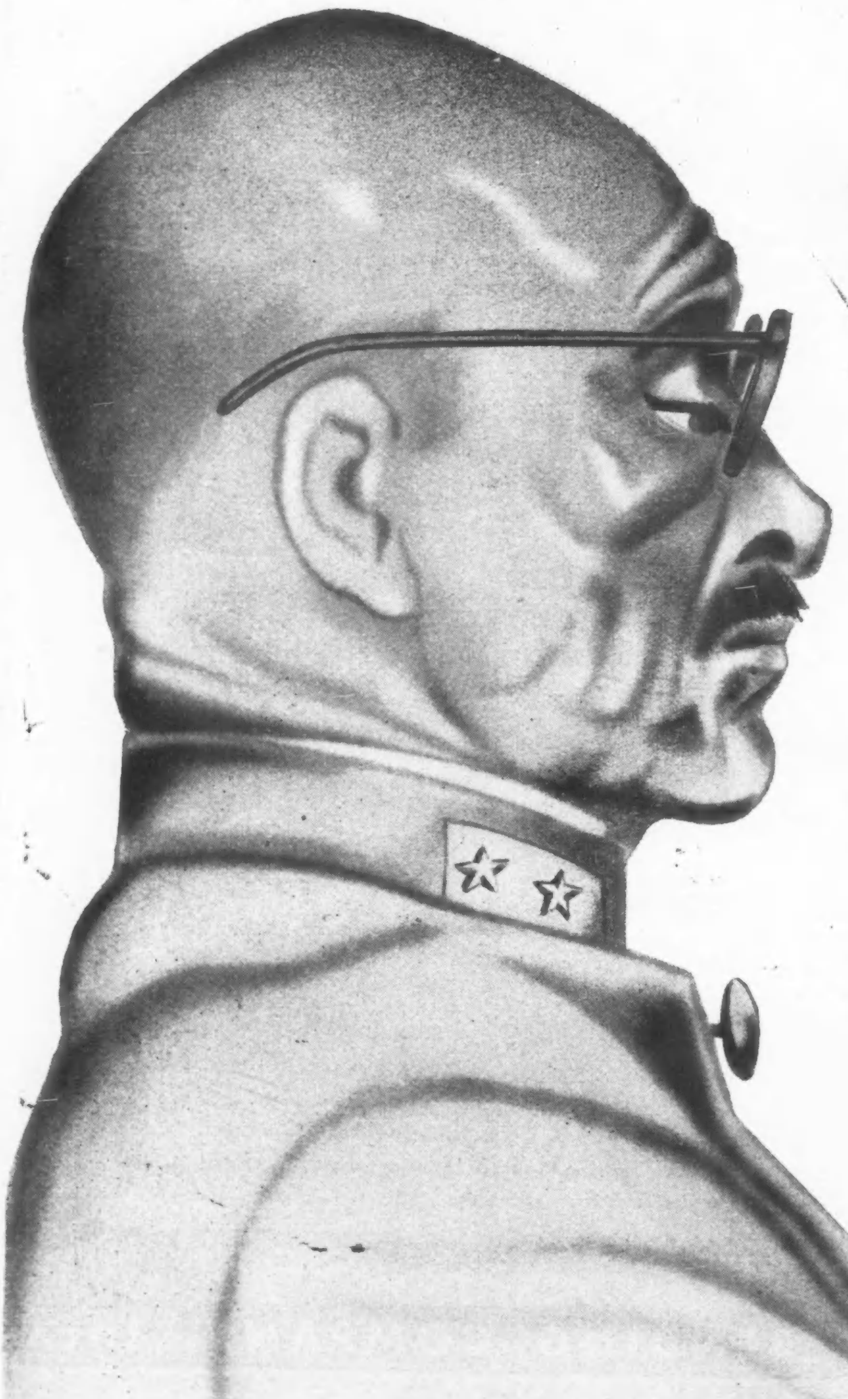
. . THE FIRST NAME IN TUBE BENDING
AMERICAN
59507 Latest Change
CLEAN
D-59507
Circumventing Obstacles!
This is the cartoonists conception of a neat job made of the complicated manifold for the sensational new ARMY SIKORSKY HELICOPTER. During the past 33 years this company has turned out thousands of problem pieces—Intakes of aluminum and steel, Oil lines of brass and copper, Collectors and Manifolds and Complicated Assemblies for builders of engines for the automotive and aviation industries. Put your problems up to headquarters.
AMERICAN
FREE TO Designers, Engineers, Production Men. This book shows nearly 200 of the custom made tubular products made in our plants.
AMERICAN TUBE BENDING COMPANY, Inc.
7 Lawrence Street, New Haven 11, Conn.

Then he said to himself

"VERY COMPLICATED, PLEASE"



Mild piece of understatement is that which Premier General Hideki Tojo made to his 83rd special session of the Japanese Diet:

*"The present war situation is very complicated. The enemy who was defeated at the beginning * * * is overcoming many difficulties and dangers."*

Of course, Tojo has read how *Recourse to Arc Welding* enabled us (his enemy) to fan out ships and planes and arms at spots which complicated his war situation.

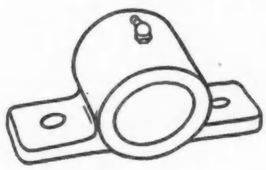
But perhaps he has not read of the mountains of little procedures, recourse to which overcame many difficulties and dangers for our production men.

"OVERCOMING DIFFICULTIES AND DANGERS"—*he says*

Look, Tojo: How having *Recourse to Arc Welding,* the production of war tools became *very simplified* for us . . . while their effect really made your position "VERY COMPLICATED."

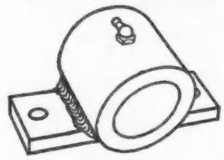
And think how in postwar they will make competition "Very Complicated" for a great many standpatters in production techniques.

VERY COMPLICATED, PLEASE



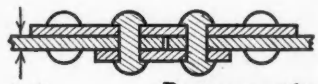
Drum shaft bearing . . .
Make pattern . . .
Mould . . .
Sand-blast . . .
(Cost in rough, $1.05)
Bore . . . Machine . . .
Drill holes.

VERY SIMPLIFIED, THANKS



Cut strap and drill holes . .
Saw piece of tubing . . .
Arc weld into unit. . . .
Total cost $0.50.

VERY COMPLICATED, PLEASE



½"

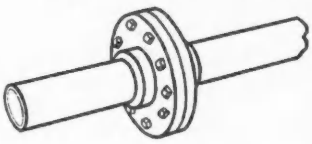
Structural joint requiring ½" plates . . .
Layout plates and straps accurately . . .
Drill holes accurately . . .
Put red-hot rivet in each hole . . .
Buck up and hammer down rivet heads . . .
Joint efficiency: 81.3%
Capacity: 24,390 lbs. per inch.

VERY SIMPLIFIED, THANKS

7/16"

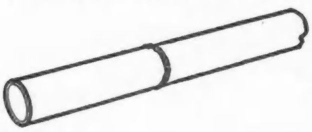
Only 7/16" plates required . . .
Bevel edge of plates . . .
Arc weld plates . . .
Joint efficiency: 100%
Capacity: 26,250 lbs. per inch.

VERY COMPLICATED, PLEASE



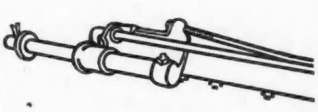
Connection in 10" steam pipe line . . .
Cut and thread ends of pipe . . .
Assemble with 2 flanges, gasket and set of bolts.
Joint requires maintenance.

VERY SIMPLIFIED, THANKS



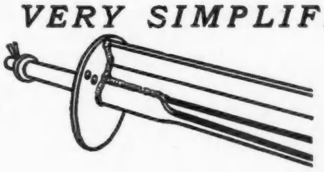
Arc weld bevelled-end pipe . . .
A permanent, leak-proof joint.

VERY COMPLICATED, PLEASE



Axle for hay rake . . .
Make dies . . .
Forge parts . . .
Machine to fit . . .
Thread truss rod . . .
Assemble by bolting . . .
100% cost for loose-working assembly.

VERY SIMPLIFIED, THANKS



Cut angle, strap, bar and plate . . .
Arc weld into one unit . . .
70% cost for permanent assembly.

THE LINCOLN ELECTRIC COMPANY • CLEVELAND 1, OHIO

America's greatest natural recourse
ARC WELDING

that the area which he was seeing and plotting for the first time in the history of man would one day be one of the world's principal trade routes between the United States, Russia and China. Before this becomes an established fact we will have to have a greater knowledge of the character of the storms which seem to build up over this barren waste and their "depth" in the atmosphere. Man has but scratched the surface of air transport and we have done well with the pitifully small amount of knowledge we have. Each advance in knowledge requires the perfection of new tools and the war has helped in this.

Transportation

We read much pro and con on the merger of transportation lines, rail, water and air. Why not keep each separate and distinct and let the competition resulting from this keep each on its toes. Merger of competing lines means lessening of competition and often death. When I was much younger the steamship lines of Long Island Sound did a land office business and were merged with the competing railway lines. Today only the lines which did not merge are alive. The old canal companies in this country did a fine business and would be doing the same thing today had they not been bought by the railways and then surpressed in order to throw the traffic in coal hauling to the rails.

Rail men are rail-minded, steamship men are ship-minded and airplane men are air-minded. Let each follow his particular line and above all keep the politicians and political appointees out of all three.

Airlines During War

We hear much about bomber pilots and fighters, but very little of the pilots of all nations who are still flying the air commerce of the world often over enemy territory or near it, hoping against hope that a fighter plane will not knock him down. Lisbon is the hub of some of this activity and there you can see the planes of warring nations sitting side by side on the airfield. The pilots who deserve unlimited credit are those who have flown China's commercial air fleet for the past 10 years even when we were building motors, propellers and planes for the Japs and loading their tankers with high octane gas, with which to do their hunting.

Fabric

We can all remember the time when "Sea Island Cotton" was the last word in tire body material. Here again man has outdone nature and when rayon was substituted for cotton, tires were stronger, internal friction was lessened and they wore longer. Now Nylon has been used to replace rayon and the resulting tires are lighter and much stronger than either those made from cotton or rayon. This will help both the motorist and airman, but bring no joy whatever to the ladies.

Controls

After the war we will have all sorts of litle electric motors which are marvels of power and stamina, high pressure hydraulic systems, etc., now used in aircraft controls. Several years ago I was shown a type of hydraulic control which was extremely clever, consisting of a sylphon on each end of a tube. When the system was filled with fluid one sylphon was extended and the other collapsed, thus when one was opened or closed the other moved in exactly the same degree and direction.

The Boys in the Services Look for Letters from you

Cooling Tests of Two Airplane Generators

Indicative of the thoroughness with which every part of American warplanes is selected and made fool proof is the series of generator cooling tests conducted by North American Aviation engineers. Two Type O-1 generators, manufactured by different companies, were installed, one at a time, in an A-36A airplane and identical flight tests run on each to determine their cooling characteristics.

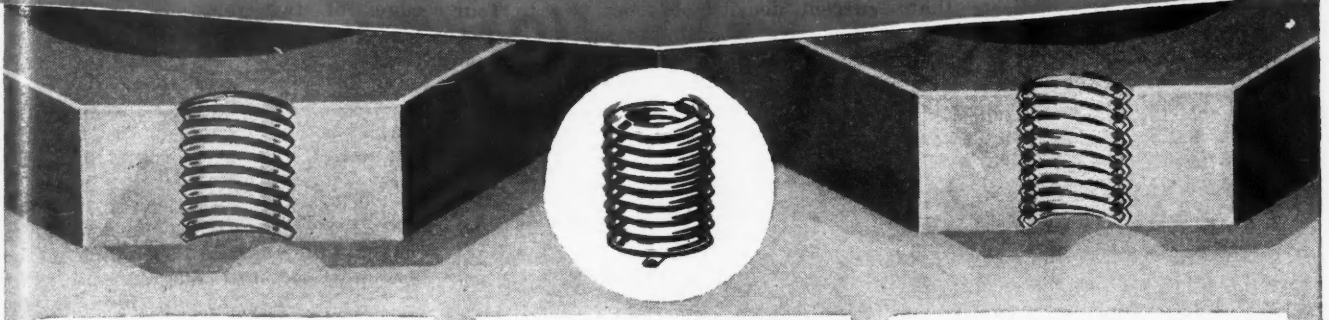
A special pitot static tube was installed in the generator cooling tube and attached to an airspeed indicator located in the cockpit. A fine wire thermocouple was then placed in contact with the generator field ring and the leads attached to a Lewis potentiometer, Model 73PO. To assimilate the load on the generator, a resistor of ⅜ ohm was placed in the circuit between the positive bus and the ground. This resistor was connected through a relay, and the relay, in turn, was controlled by a switch on the pilot's panel. All readings and data obtained were recorded by the pilot.

One test was run at 20,000 ft. and an indicated air speed of 180 mph, while the outside air temperature was 12.5 to 15 F. Three other tests were conducted at the 1000 ft. level at indicated air speeds of 170,200 and 230 mph, the outside air temperature being 65 to 68 F. Engine speed averaged approximately 200 rpm and generator speed about 2900 rpm. The speed of the air delivered by the generator cooling tube varied from a low of 66 mph to a high of 93 mph. This flow of cooling air was found to be more than sufficient to maintain ample generator cooling even at 30 per cent greater load (88 amps total) than normally demanded by the installed electrical equipment in this type plane.

In a span of generator speed of about 500 rpm, from approximately 2600-3100 rmp, it was found that the generator temperature had increased, although not dangerously so, as much as 35 deg. It was thought that most of this temperature rise was due to increased engine heating with increase in air speed.

To prove this belief, a laboratory set up of one of the generators was made at a constant load of 90 amps, outside air temperature of 91 F and with a constant flow of cooling air. It was found that in a speed range from 2600-4500 rmp, the increase in generator field ring temperature increased only 12 deg. For the 500 rmp span previously mentioned, the actual increase in field ring temperature due to generator heating alone was found to be only 2 deg.

HOW TO PUT A *Steel Thread* IN AN ALUMINUM HOLE!



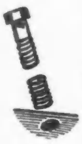
This unprotected tapped thread in Aluminum will wear rapidly may even strip **BUT**

Take this precision-shaped stainless steel "Heli-Coil" Screw Thread Insert **AND**

Insert it in the tapped hole. Now you have, in effect, put a long-wearing steel thread in an aluminum hole.

USED IN ARMY, NAVY AND TRANSPORT AIRCRAFT ENGINES, ACCESSORIES AND PARTS FOR.

SALVAGE • MAINTENANCE FIELD SERVICING AND ORIGINAL INSTALLATION



"Heli-Coil" Screw Thread Inserts provide a simple and inexpensive method of protecting tapped threads in light metals and plastics against abrasion, stripping and seizing. Furnished in stainless steel or phosphor bronze, they can be installed quickly with hand or power tools. Manufacturers of aircraft engines and accessories use "Heli-Coil" Inserts in applications where solid screw bushings were used previously. In fact, almost the entire output of this Company is used for aviation purposes today. These inserts are used not only in original construction, but in salvage, replacement and maintenance—in the factory and in the field. The fact that they meet the rigid requirements of aircraft engine manufacturers indicates wide usefulness throughout industry after the war. Send for engineering literature.

Heli-Coil INSERTS SAVE

TIME

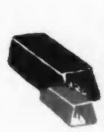
Can be installed with simple hand or power tools in one-fourth the time required for solid screw bushings.

WEIGHT

Weighs one-fifth as much as the screw bushing of the same diameter.

SPACE

Occupies less than half as much cross sectional area as solid bushing, permitting more latitude in design.



METAL

Made from precision-shaped wire with no waste, requires about one-tenth as much metal as solid bushing made from bar stock.

U. S. and Foreign Patents Issued and Pending

THE SCREW SYSTEM WITH THE ANTI-FRICTION THREAD LINING

AERO-THREAD

AIRCRAFT SCREW PRODUCTS COMPANY, INC.

47-23 35th STREET • LONG ISLAND CITY, 1, N.Y.

Porous Chromium for Engine Cylinders

*By H. Van der Horst and Russell Pyles**

Porous chromium can be applied to steels of all descriptions, as well as cast iron, with adequate bonding. Recent developments also indicate that equal success may be obtained in applying chromium to aluminum. For engine cylinders or blocks, the plating procedure is briefly as follows: After the initial etching, the cylinder or block is lowered into the plating solution, and electro-deposition starts at a current density of from two to four amps. per sq. in. of surface area. Higher current densities are possible but often give rise to an uneven deposit, to building up ridges on port edges of two-cycle engine cylinders, and are therefore undesirable. Time of plating may vary from 2½ hours to 15 hours, depending upon the thickness of deposit required. After plating, the assembly is put back into the original etching solution and it is this operation which gives the porosity which is so essential. The cylinder is contacted as the anode and as soon as the current is applied, stripping of the chromium begins. The curious effect of this is that the chromium is not stripped in layers of the surface, but in depth. As much as 30 per cent of the chromium deposited may be removed, with no decrease in diameter. The sort of porosity that is obtained because of the reversing of the current depends entirely upon the crystallitic structure of chromium which has been deposited. We may get the channel type porosity, or the standard porosity which is often called the "coal pile."

A question that is often asked is what thickness of chromium is required, and the answer is that it depends upon the lifetime expected from the engine. An automobile engine and an aircraft engine are both short-lived, and 2000 hours running is quite a lifetime. A large Diesel engine, either for marine or for other purposes, is expected to last thirty to sixty times longer. Approximately 0.006 in. on the diameter in an automobile engine will make it outlast the life of the automobile, but .030 in. on the diameter in a marine Diesel, particularly a two-cycle, is not even enough; in fact it usually lasts only about eight years, or 40,000 hours. Such cylinders have then been sent back to the factory to be stripped, honed and replated, and have been put to useful service again.

Porous chromium on aluminum—Several methods are available for plating chromium on aluminum, but these methods call for a pre-plating of the base aluminum with either copper or nickel or sometimes both materials. In general, it would seem more desirable to apply chromium directly to the aluminum if this could be possible, for every time a plate of another material is interposed between the base material and the final wearing surface, the possibilities are increased for difficulties with the bonding. Too, there are many more steps wherein trouble may be en-

(*Turn to page* 236, *please*)

* This article is an abstract of the paper presented by the authors at the War Engineering—Annual Meeting of the Society of Automotive Engineers on Jan. 13 in Detroit.

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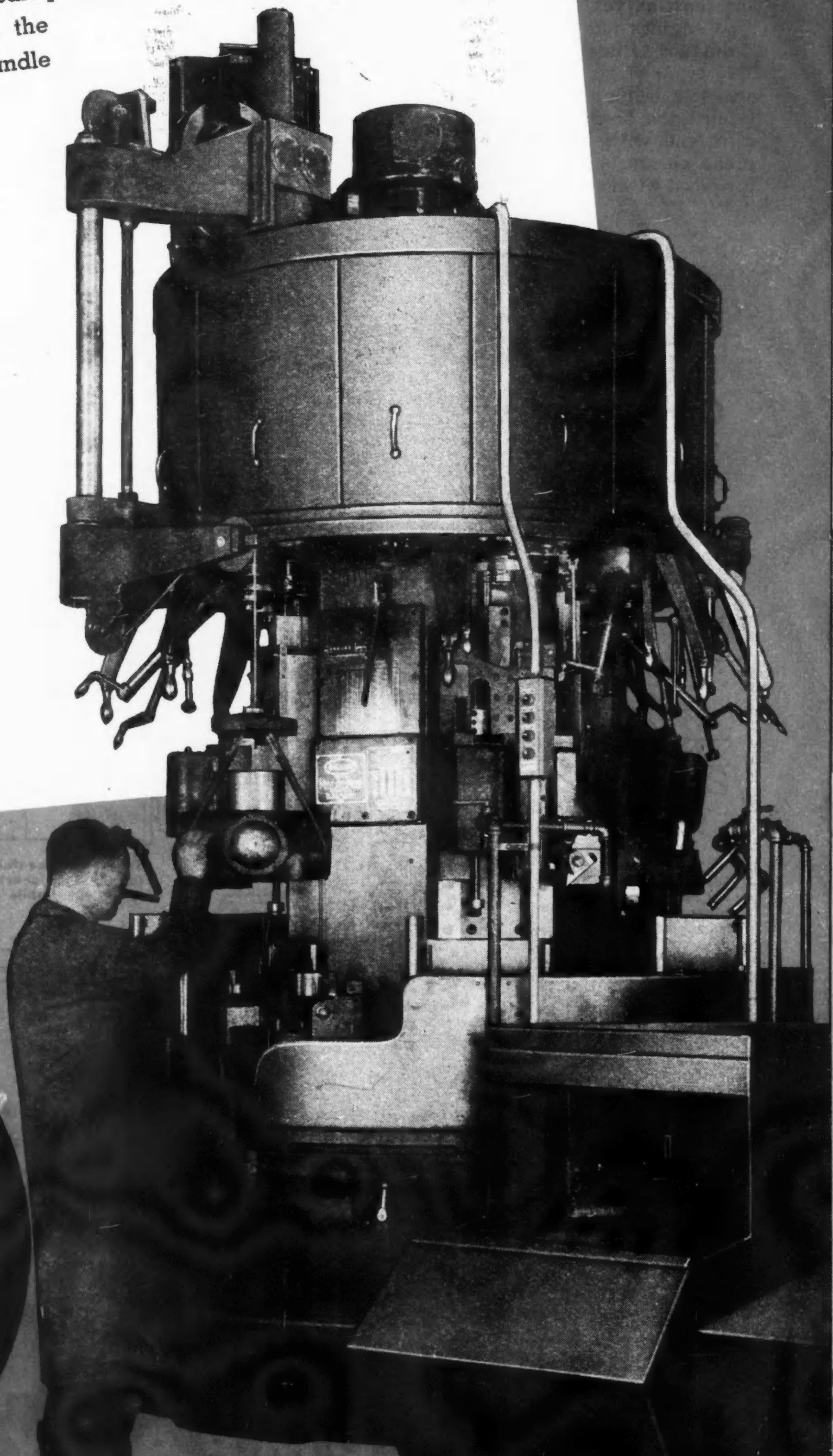
SPEED THE ATTACK
WITH ARO
PNEUMATIC TOOLS
America's production lines can send more bomb-loads into Nazi-land and Jap-land...by speeding up small tool jobs with ARO Pneumatic Tools! Whether it's drilling, nut-setting, screw-driving, grinding or countless other small tool operations...ARO Pneumatic Tools get the job done *right!* Though small in size and light in weight, the ARO Tools pack tremendous power. This means faster production, greater efficiency, less fatigue—ideal for women! ARO Tools are *tops* for rugged... dependable ... stall-proof operation. Write for your catalog today... The Aro Equipment Corporation, Bryan, Ohio.
A handful of power in this new ARO Model 101 with plastic housing and handle—weighs only 1 lb. 9 oz.—operates full ¼-inch drill.
PNEUMATIC ARO TOOLS
THE ARO EQUIP. CORP.
BRYAN, OHIO

. THE SOONER WE'LL WIN

One of the striking developments, as America's war machine goes into high, is the widespread entrance of the Mult-Au-Matic in fields which before the war were thought to be largely the province of small-scale production to extremely fine limits. In building airplane engines, for instance, the Mult-Au-Matic has proved its ability to handle scores of individual jobs . . . with no sacrifice in precision, and with the tremendous increase in volume long familiar to America's mass production industries. On many operations the Mult-Au-Matic method cuts machining time to a small fraction of the old-fashioned single-spindle method. On hundreds of production lines today, even though the ranks of skilled workmen are being thinned . . . Mult-Au-Matics are helping fewer men to produce more work.



One of the big Type D "16-23" 8-Spindle Mult-Au-Matics machining barrels for airplane propellers. This larger Bullard is built to handle heavier work — note the hydraulic hoist mechanism for easy chucking.

COMPANY BRIDGEPORT 2 CONNECTICUT

(*Continued from page* 232)
countered. For this reason, it is believed that the desirable solution lies in the direct deposition of chromium on aluminum. Methods have been developed for accomplishing this and to date they show considerable promise of success, although it must be pointed out that, as yet, experience in service type engines has not been obtained.

Surface Finish and Wettability—Two types of porous chromium surface are now being used. One of these is termed the "normal" porosity because it is one with which we have had a great amount of experience and it is produced within a relatively wide range of plating conditions. Another type of surface, known as the "channel" type has also been produced for a period. This type requires much closer control over all plating conditions. Cylinders of both types have gone into service, but most of the cylinders in Diesel service are of the normal porosity type for the reason that its production limits are wide. Recent experience has indicated that for some types of engines there may be a preference and it has been reasonably established that for airplane cylinders the channel type has somewhat superior characteristics.

Experiments lead to the belief that the oil film on the plateaus of both normal and channel finishes is very thin—perhaps only a couple of molecules thick—too thin to fluoresce visibly, but not too thin to produce a slight change in general color of the surface, and not too thin to play an important part in boundary layer lubrication. The mechanism of oil spreading on porous chromium is apparently capillary in character, a phenomenon not observed on steel and cast iron. The greater rate of dispersion on channel type chromium surfaces can be attributed to the system of canals or arteries which reduce the distance to be traveled by capillary action.

The pores and channels serve another useful purpose beside aiding in oil distribution. Pressures producing boundary lubrication conditions squeeze out the lubricant from between the mating surfaces. The smoother the surfaces, the greater will be the real area of contact and it follows that the oil volume displaced will be greater. The channels and pores provide reservoirs wherein this oil can be trapped and immediately available for re-wetting the surfaces after load removal, preparing it again for its next load cycle.

The desirable surface geometry for boundary lubrication seems fairly well established and consists of highly polished flats interspersed with pores or channels, which are all below the plane of the plateau. This is precisely the geometry of an edge section through porous chromium. Further improvement may be gained by additions to the lubricating oil such as long chain polar compounds and chemical polishing agents. Extensive research has been done and is still in progress by able investigators in the physicochemical field of lubrication, and it is gratifying to see that the hazy realm between boundary layer and hydrodynamic lubrication is fast clarifying.

Inspection of the Porous Chromium Surface—Experience has demonstrated the importance of the porous chromium surface condition and it has been necessary to develop inspection methods for its control. Visual examination with a 50 power microscope has been reasonably successful but requires considerable training and judgment on the part of the inspectors. For the estimation of per cent porosity, photographs have been made of surfaces of various degrees of porosity. This is a comparative method, the appearance of the cylinder surface being compared with a known porosity. The known porosity on the photo is obtained by planimetering either the flat or below the surface areas of a photomicrograph. The per cent porosity can also be quickly determined particularly with the channel type by cutting up the photomicrograph with scissors and weighing the plateaus and channels on a chemical balance. The close agreement between this method and the planimeter is surprising.

Work is also progressing on the adaptation of the photo-electric cell as

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THE "HELL DIVER" . . . RABAUL

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a measure of porosity. We have connected a high vacuum photocell to a vacuum tube circuit which contains a microammeter. When the instrument is properly calibrated, the meter reads directly in per cent porosity. The circuit is linearly sensitive to the amount of reflected light and with vertical illumination total reflected light is proportional to the total area of flats or plateaus. The instrument can be calibrated at each end of the scale by using a disc covered with dull black paper for 100 per cent porosity (zero reflection) and a polished chromium plated disc for zero porosity (maximum reflectivity). Intermediate check points are obtained by using discs of porous chromium with known degrees of porosity determined by planimetering of photo-micrographs. Laboratory checks indicate that the instrument calibration holds equally well for either normal or channel type porosity.

Rubber Sheets Now Used On Stretching Machines

By substituting rubber sheeting for grease on the blocks of stretching machines, this change has resulted in improvement in practically every phase of processing large metal sheets into airplane "skins" at the Glenn L. Martin plant. Before the 1/32 in. thick elastic "lubricant" was adopted, operators of the stretching machines covered the blocks with a thick coating of the grease. After the "stretching" process was completed the sheets were placed on the floor where a second group of employes removed as much of the grease as possible with rubber scrapers and wiping cloths.

Following this cleaning work the sheets were taken to a scribing table, followed by trimming and cutting out of sections. Because those sections had a burred edge after being cut, they were moved along to another group who removed those burrs with scraping tools and files. When these operations were completed, the parts were moved into a hot vapor bath pit where the grease was removed. Then the parts were numbered and, after being loaded into containers or on skids, they were sent to other departments for finishing operations.

With the adoption of the rubber sheeting method production immediately soared, Frank Weisner, foreman of the Stretching Machine Department, explained. "The new plan saved production costs in a number of ways," he said. "Our total department output was increased almost 50 per cent. In addition we saved the excess cost of the grease which was much more expensive than the rubber sheeting, the machines and tools do not have to be cleaned each shift, we eliminated a number of safety hazards, we keep the department much cleaner, and we're doing more work with fewer people."

Surface Finish Tests for Evaluating Cutting Oils

By H. L. Moir, J. S. Yule, D. J. Wangelin, and R. J. Moyer, of The Pure Oil Co.*

THE relation between finish life and tool life is not the same for all cutting oils. For example two oils may produce the same tool life at a given cutting speed, but the finish life for one oil may be considerably longer than for the other oil. We have devised a test which rates oils according to finish life as well as tool life, the former being defined as the length of time that a tool will cut at a given speed without appreciable change in finish. It is either less than or equal to tool life. Finish life may be determined by visual inspection or by measurement of the surface roughness with a suitable instrument. It is often possible to find pronounced visible finish changes, when cutting with oil, long before the tool has completely failed.

To detect less noticeable finish changes a surface comparator instrument was built. It consisted of three principal parts—the pickup unit, the amplifier and the meter. The pickup unit was made from a phonograph crystal cartridge with a sapphire tipped needle and the pickup arm was free to rotate. With the surface comparator in the operating position, the lathe cross slide was set in such a position that the needle was directly over the axis of the work. The needle was

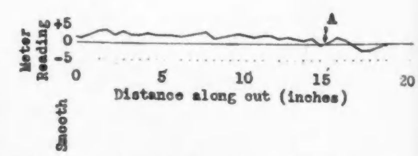


Fig. 1—Finish readings for oil "C"

made to travel in the cut by using the same feed per revolution that was used when the cut was made. Finish readings were made when running the lathe at a speed of about 30 surface fpm, this slow speed being used to minimize the needle wear. The pickup unit was connected to the amplifier and meter. The meter reading gave an indication of relative roughness, the higher the reading the rougher the surface.

Finish life tests were run in conjunction with tool life tests so that a comparison could be made between the two. The tools were first run to tool failure and then the surface inspected for finish failure. After each tool was run,

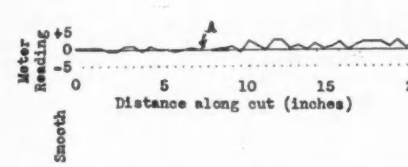


Fig. 2—Finish readings for tool cutting dry

the surface was marked off into half-inch increments. Finish measurements were made at each mark so that finish readings could be plotted against length of cut. Fig. 1 shows the curve produced from the readings taken from one of the cuts on oil "C." At the point A a visible finish change was noticed. Attention is called to the fact that the finish did not change much up to this point. Fig. 2 is a similar curve for one tool cutting dry. In this case there

(Turn to page 420, please)

* This article is an abstract of the paper, "A Method for Testing Cutting Oils," prepared by Messrs. Moir, Yule, Wangelin and Moyer for the 1944 War Engineering-Annual Meeting of the Society of Automotive Engineers in January at Detroit.

Photographs Prove

WHAT "Graf-Flox" DOES

Now, through laboratory photography, you can see just *what* "Graf-Flox" is . . . what the process does to the surface of Burd piston rings . . . and *why* Burd "Graf-Flox" rings are piling up unusual performance records in rering, rebore and reclaim jobs.

The secret lies in (1) electric furnace iron with evenly distributed graphite throughout (2) complete removal of the "smear layer" or film of metal left by machining. With it are removed the clinging particles that won't *wipe* off. (3) the filling of the open pores with colloidal graphite to form a dense, 100% graphite surface firmly fixed to the iron.

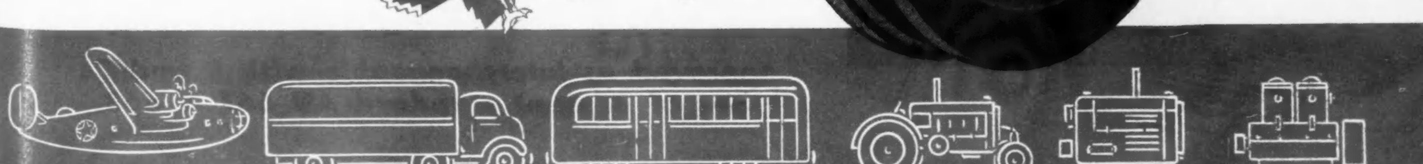
These are the reasons why Burd "Graf-Flox" rings lubricate . . . provide instant seating . . . eliminate run-in . . . assure a lasting finish. Born in the laboratory, tested on the speedway, Burd "Graf-Flox" Rings are now proving themselves on land, sea and in the air.

BURD PISTON RING CO., ROCKFORD, ILL.

Check THESE ADVANTAGES!

- ✓ **No abrasive materials,** either added or arising from machining operations, to endanger cylinders at start, or after wear occurs.
- ✓ **No run-in needed.** Graphite face seats to fit cylinder wall in first few seconds after starting engines. Saves oil from the start.
- ✓ **No loss of cylinder polish,** no roughening of surface; lengthens life of rings, pistons, and cylinder bores.
- ✓ **Lubricated lands.** Graphite surface reduces friction regardless of heat, helps ring following cylinder at higher speeds, holds down oil consumption.

BURD "Graf-Flox" PISTON RINGS



What to Do Before Termination

Following is a preliminary check list which has been compiled by the National Association of Manufacturers to show the steps which prime contractors, subcontractors and suppliers in all tiers should take regarding termination of war contracts:

1. Establish proper internal organization for handling terminations

(a) Under an advisory committee representative of top management and major departments affected;

(b) with a responsible executive in charge;

(c) free from other responsibilities so as to give adequate attention to termination;

(d) trained to understand, develop, direct and coordinate the over-all plan for termination of contracts.

2. Review Contractual Relationships

(a) Develop simple reference notations on the different provisions of termination clauses, giving special attention to contracts likely to be cancelled.

(b) Convert "letters of intent" and other informal orders.

(c) Assure inclusion of satisfactory termination provisions in new contracts, and reasonable protection in new purchase orders.

3. Check Financial Policies and Company Status

(a) Take advantage, if necessary, of guaranteed bank loans.

(b) Become fully familiar with partial payment provisions.

(c) Consider payments which will be required to subcontractors and suppliers.

(d) Determine auditing requirements for approval of subcontractor and supplier claims.

(e) Plan financing to cover purchase of surpluses.

4. Anticipate and Plan for Production Control Problems

(a) Review potential problems with plant managers.

(b) Be currently informed on need of your goods, production of which might be terminated.

(c) Establish policy for transfer or lay-off of employes no longer required.

(d) Prepare "stop work" notices, and material and supply orders for immediate transmission to all control centers and to subcontractors and suppliers.

(e) Plan for confirmation of telegraphic notice to your vendors, adding

1. identification of prime contractor and contract or order number.
2. instructions in light of government's notice, applicable conditions of sales and regulations on what to do with completed items not shipped, work-in-progress, material on hand and commitments with their own vendors.

5. Analyze Inventory Disposal Problems

(a) See that raw materials, purchased parts and work-in-process are properly identified with customer's contracts or orders.

(b) Be sure that inventories are reasonable and in line with monthly program requirements.

(c) Maintain segregation of all government-owned supplies, tools, equipment and facilities, and be able to account for same.

(d) Be prepared to allocate and physically identify inventory of terminated war-contracts, or of government

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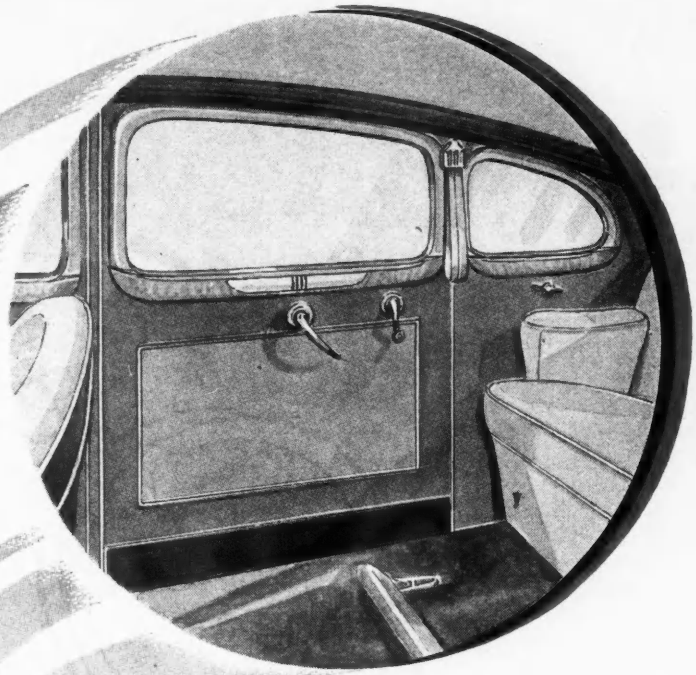


START FULFILLING THE PROMISE

EVERYBODY expects the post war world to be lightened and brightened with featherweight metals and rainbow plastics.

Glorifying the interior of passenger cars with Formica laminated plastic door panels—front seat backs—kickers presents no time consuming engineering problem.

The material is ready in colors to harmonize with the upholstery or instrument panel or metal trim. Formica has been used and proved successful as panelling in taxicabs. It is not damaged by grease, dirt, alcohol, cigarettes, or kicking feet. It holds its dimensions. It retains its lovely color and finish throughout the entire life of the car, and can be kept clean with a damp cloth.

This is an improvement that adds beauty and longer life, is expected and will be welcomed.

THE FORMICA INSULATION COMPANY
4612 Spring Grove Avenue, Cincinnati 32, Ohio

contracts in process, civilian production and company stockpile.

(e) Protect at reasonable costs inventory of terminated contracts until properly released.

(f) Learn conditions requiring contractor-agent approval prior to disposal.

(g) Adopt policies, price and charge standards, for disposal of surpluses.

1. retained (or purchased) for use on other orders.
2. sales to third parties,
3. scrapping,
4. delivery to government.

(h) Pre-plan immediate taking of inventory as soon as "stop-work" orders are issued.

6. Study Preparation of Claim

(a) Maintain a listing of superior subcontractors and suppliers related to each contract.

(b) Organize for prompt summarization of all open purchase orders and commitments.

(c) Assure speedy compilation of both direct and overhead costs allowable to terminated projects.

(d) Consider handling charges where costs have been incurred in other than contract production.

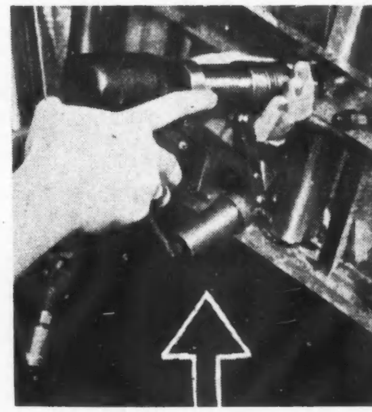
(e) Survey the factors of post-temination expense.

(f) Prepare instructions, suggested forms of other facilities to aid prompt filing of claims by subcontractors and suppliers.

(g) Confer with, or otherwise satisfy yourself that subcontractors and suppliers will not cause you harmful delays by late or inadequate filing of their claims. Consider, for instance, the merit of establishing an understanding and working relationship between your own company and your prime or subcontractors and suppliers that will be conclusive of the coordination of claims and prompt settlements.

Automatic Control On Riveting Gun

Consisting primarily of a cylinder, piston and spring, this attachment on the riveting gun controls the number of its strokes and thus prevents "stress areas." It was designed by Otto Peters at the Willys-Overland plant.



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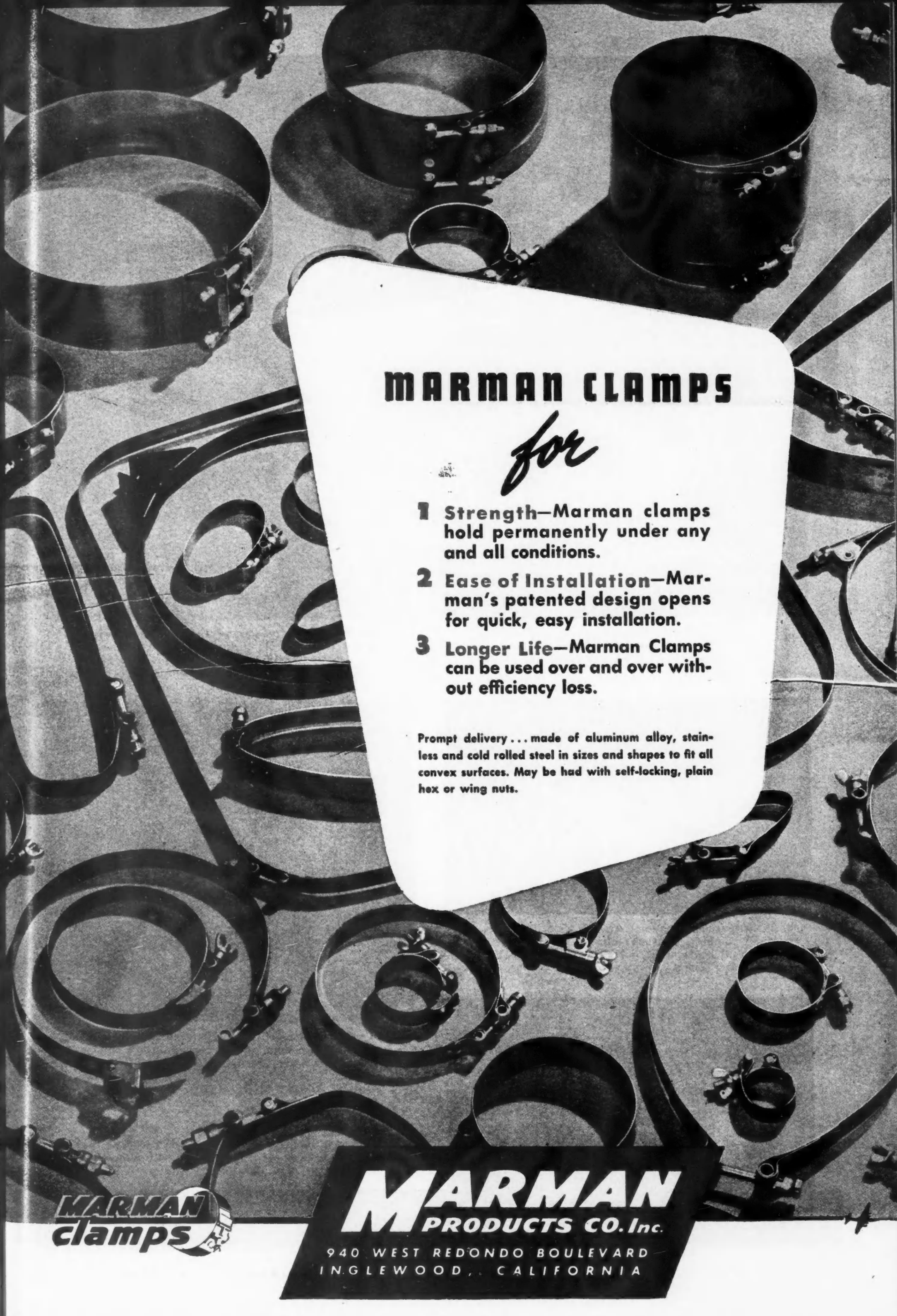
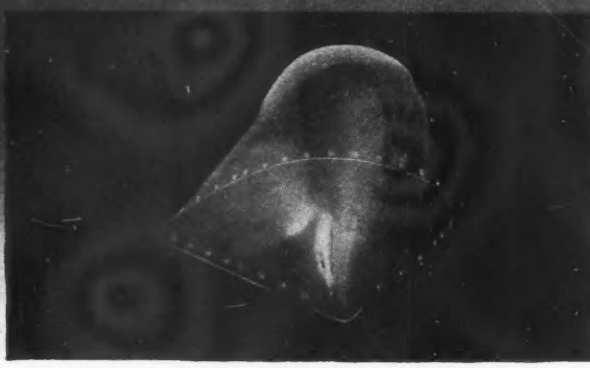
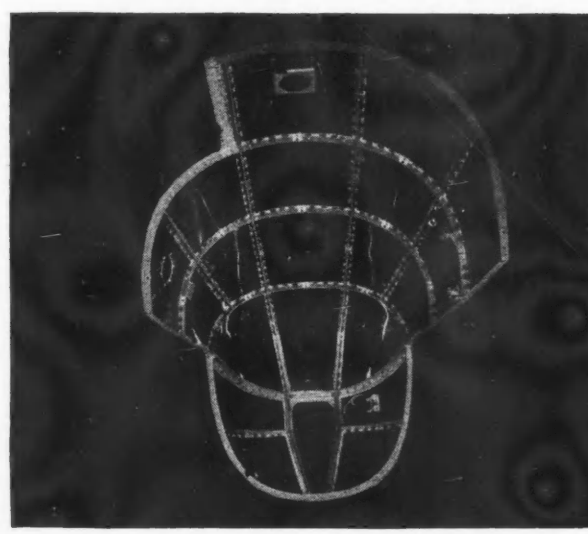




1 Tail cone of "Lucite" enables an observer to look back and check the result of a bomb-run over the target. Latest B-25 carries a machine gun at this tail position.

2 To give the turret gunner a clear view overhead and to each side, North American provides another enclosure of Du Pont "Lucite" here. Notice how few reinforcing ribs are needed for rigidity.

3 Pilot's enclosure in North American's Mitchell medium bomber is another multi-section structure in which all transparent portions except the windshield are "Lucite".



4 Twenty sections of "Lucite" are used in the bombardier's "greenhouse." At the upper left will be the escape hatch, not built integral with the enclosure. This enclosure has been changed on new "attack models" of the B-25 to accommodate a 75 mm. cannon.

5 The astro-dome of "Lucite" in the B-25 lets the navigator shoot the sun and stars with almost all the clear vision of open air.

BETTER THINGS FOR

Truman Report on Wartime Motor Transport

Supplementing its report on transportation made to the United States Senate on Dec. 15, 1943, the Special Committee Investigating the National Defense Program (Truman Committee) in its third annual report released March 5 summarized the motor transport situation in this country as follows:

The committee emphasized in its report and reemphasizes now the necessity of taking adequate measures to enable the motor-trucking industry to carry the burden of wartime transportation required of it. Shortages of new equipment, replacement parts, tires, and manpower will make that difficult.

Those and other factors have combined to increase the expense of trucking operations to such an extent that very little profit remains to the average truck operator. According to preliminary estimates, the average national ratio of operating expenses to operating income for 1943 was approximately 97 per cent, as compared with 93 per cent for the year 1942. The operating expenses of some truck operators exceed the revenue they are receiving. This requires them to face the prospect of continued operation at a loss, which they can ill afford from their slender resources, or to abandon operations with a loss to the war program and with a loss to themselves of the business and good-will relations which they have taken pains to build up over a period of years.

In order to insure continued operation, some carriers have filed master tariffs providing for 4 per cent rate increases, although some others who are eligible have not yet done so.

In the interim report on transportation, the committee recommended to the War Department that it rigorously reexamine its estimates of need for new trucks. Pursuant thereto, the War Department has reduced its request for 742,433 new trucks in 1944 by 123,149 trucks. This reduction of more than 15 per cent will be accomplished by eliminating requests for 42,013 medium trucks and 81,186 light trucks.

This will represent a substantial saving, but it will produce only limited benefits to the civilian trucking industry. The savings are accomplished by factory reconditioning and rebuilding of trucks already in the possession of the War Department. This will be much cheaper than building new trucks. But the factory reconditioning and rebuilding will absorb some of the facilities which would have been used for the production of new trucks. Consequently the benefits to the civilian trucking industry, although important, will not be sufficient to alleviate the shortage of trucks.

The situation with respect to the manufacture of heavy trucks, in which truck operators are most interested, still remains extremely tight.

As noted in the interim report, steps had been taken to increase the production of replacement parts. Previously, however, during the period of shortage of high-grade steel, many parts were produced out of inferior materials so that the parts which were available gave less miles service. The benefit of making more and higher-grade parts available to the operators has not yet appeared to any substantial extent, although the industry can look forward to improvement along this line in the near future.

As pointed out in the previous transportation report, military requirements for trucks were vastly increased during the latter part of 1943. This placed a severe strain upon the facilities to meet the already heavy demand for new tires. Although progress has been made, the demand for new tires will be

HOW 3 SUNDSTRAND SPECIAL PROCESS MILLING MACHINES

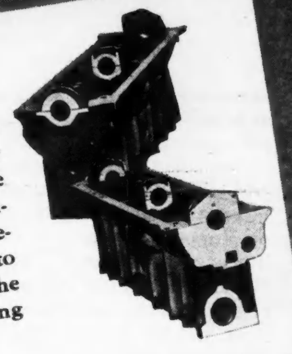
1 *replaced 18 special milling machines*

2 *saved $249,984.00 per year...in addition to increasing tool life*

3 *automatically mills 16 surfaces each machine cycle*

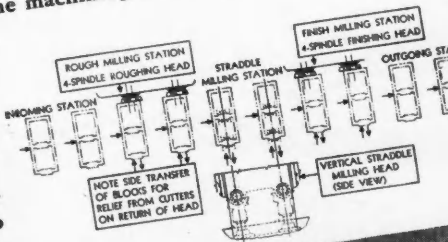
4 *produced 8,750,000 cylinder blocks in 7 years*

5 *eliminated "operator's fatigue" for 18 men*

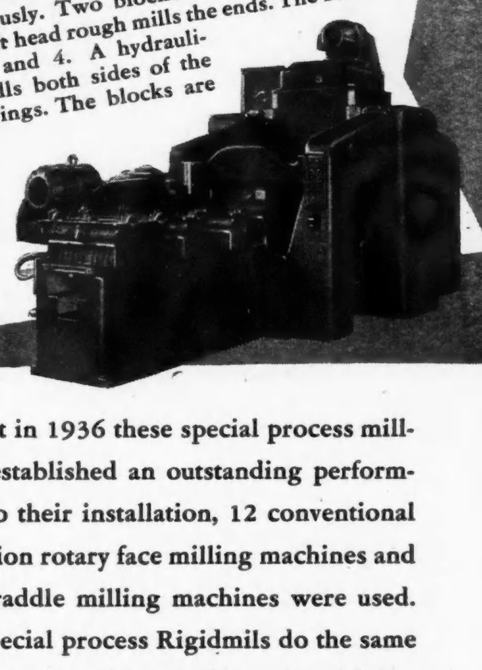


The Problem...
consists of rough and finish milling the front end and straddle milling the rear and intermediate bearing faces. The equipment used previously occupied considerable floor space and was so designed that the cylinder blocks had to be lifted from a conveyor line to the machine, a tedious and extremely tiring operation.

The Solution...
Sundstrand Engineers designed this machine to incorporate all of the operations in each of the 3 machines. This makes it possible for the operator to control the machining from a push button station. The sketch illustrates the sequence of operations and flow of blocks through the machines. Note the ingenious method of incorporating vertical milling together with the transfer sidewise, so cutters do not return over machined surfaces.

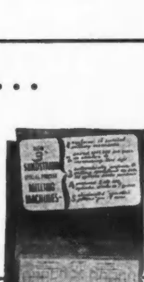


The Machine...
mills six blocks simultaneously. Two blocks automatically move into stations 1 and 2. The left head rough mills the ends. The blocks then move into stations 3 and 4. A hydraulically fed head straddle mills both sides of the intermediate and end bearings. The blocks are shuttled into stations 5 and 6. The right head finish mills the ends. The blocks are unclamped, clamped and moved automatically between each operation.



● Designed and built in 1936 these special process milling machines have established an outstanding performance record. Prior to their installation, 12 conventional special high production rotary face milling machines and 6 special vertical straddle milling machines were used. Three Sundstrand special process Rigidmils do the same amount of work at a saving of 15 machines. In addition to these savings, there is a considerable amount saved in electrical power, floor space and maintenance. Also, the previous trouble of getting the bearing faces square with the front end face of the cylinder block has been entirely eliminated.

FREE ADDITIONAL DATA . . .
is included in this folder. Additional features are stressed. For instance, 3,500 cylinder cases per grind with a 25" feed per minute, taking a ⅜" depth of stock is another accomplishment of this machine. Write for this information today. It may prove valuable information in planning present or postwar production. Ask for Bulletin No. 222.



SUNDSTRAND MACHINE TOOL CO. ROCKFORD ILLINOIS U.S.A.

ARMY E NAVY

SUNDSTRAND MACHINE TOOL CO.

Rigidmils • Fluid-Screw Rigidmils • Automatic Lathes • Hydraulic Equipment • Drilling and Centering Machines • Special Milling and Turning Machines

2571 ELEVENTH ST., ROCKFORD, ILLINOIS, U. S. A.

such that it will be very difficult to provide enough for both truck and passenger purposes.

One of the most serious bottlenecks was that of the mixing machines for mixing rubber. They are complicated machines and cannot be built quickly in large numbers. They can be used either for mixing rubber for new tires or for mixing camelback for the recapping of old tires. The production of camelback both for truck and passenger tire purposes has increased during recent months. At present, camelback for recapping passenger car tires is being produced at the rate of about 18,000,000 lb per month. At the rate of approximately 7 lb per tire this would be sufficient to recap only about 2½ million automobile tires.

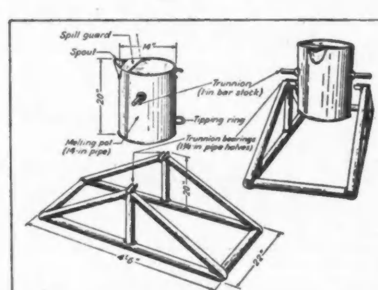
Similarly, at the present rate of production of truck type camelback, which is about 10,000,000 lb per month, only slightly over 600,000 truck tires could be recapped at the rate of around 18 lb of camelback per recap. If no greater rate of camelback production can be obtained during 1944, it would permit the recapping of only about 7½ million tires annually. This number, together with 4½ million new truck tires which the Office of Rubber Director estimates will be produced this year for civilian use, would be sufficient to provide for only about one-half of the estimated tire requirements for civilian trucks and buses. There are 4,538,000 trucks and buses equipped with more than 23,000,000 tires. The situation is most acute as to the heavy trucks.

The amount of rubber required for recapping of truck and passenger tires is only a fraction of that required to make new tires. A recap on an old carcass made from natural rubber will wear about as well, and in some cases perhaps better, than an entirely new synthetic tire. These facts require that careful consideration be given now to the proper balancing of the production of camelback for recapping against the production of new synthetic tires and to the commencement of a campaign to educate small truck operators and owners of passenger cars as to the desirability of recapping their tires before they have worn the carcass down too thin.

It is estimated that 80 per cent of the trucks are owned and operated by small firms who own less than five trucks. Many such operators have not been sufficiently urged to do recapping. In this group is the greatest increase of potential tire mileage in tires now in use. It might be advisable to spread among them more knowledge of the results being obtained by operators of large fleets of trucks, most of whom have been recapping their tires for many years.

A Method to Reclaim Scrap Babbitt

A combination storage bin and melting pot for scrap babbitt is suggested by *Oxy-Acetylene Tips* as an inexpensive device to conserve the metal and save time. When the pot is nearly full of scrap babbitt the metal is melted down by placing under the pot some convenient source of heat such as a kerosene burner. This piece of equipment, the details of which are shown in the accompanying sketch, can be made entirely from scrap material and



built by welding and cutting. Odd lengths of 2½ in. scrap pipe are used to make the cradle. A ring and a piece of rod stock in the shape of a semicircle are welded to the pot on the side opposite the spout so that tipping can be accomplished by pushing at the top and pulling at the bottom. It is important to align the trunnions on the pot correctly with their bearings on the cradle.

ON NOSE . . . BELLY . . TOP AND TAIL . . . YOU'LL FIND

Plexiglas TURRETS

HARD-HITTING power turrets bristle from American heavy and medium bombers. From nose, belly, top or tail, their guns command surrounding skies . . . ready to fight off attack from any angle.

These strategic battle stations are enclosed in PLEXIGLAS—Aviation's Standard Transparent Plastic.

The crystal-clarity of PLEXIGLAS enables the gunner to aim and fire accurately. Its strength protects him from wind, weather and freezing slipstreams. Its light weight saves precious pounds for bigger bomb loads and larger fuel supplies.

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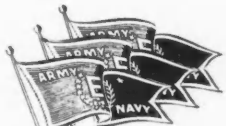
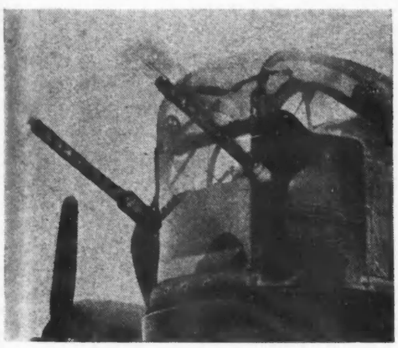
To obtain the benefits of this active assistance in your plastics development work, call our nearest office—Philadelphia, Los Angeles, Detroit, Chicago, Cleveland, New York.

***Only Rohm & Haas makes* PLEXIGLAS.**



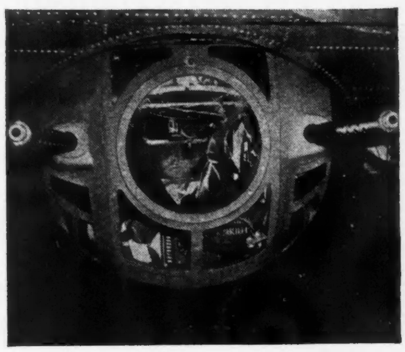
3 awards to Rohm & Haas Company and its associated firms, The Resinous Products & Chemical Company and Charles Lennig & Company.

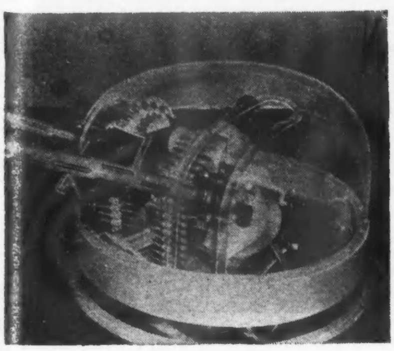
PLEXIGLAS *is the trade-mark, Reg. U. S. Pat. Off., for the acrylic resin thermoplastic sheets manufactured by the Rohm & Haas Company.*



ON THE CONSOLIDATED B-24—the new Emerson-designed, Emerson-built nose turret of PLEXIGLAS adds a fourth power-operated death sting to the other three PLEXIGLAS turrets—Martin top, Sperry retractable belly, Consolidated tail.

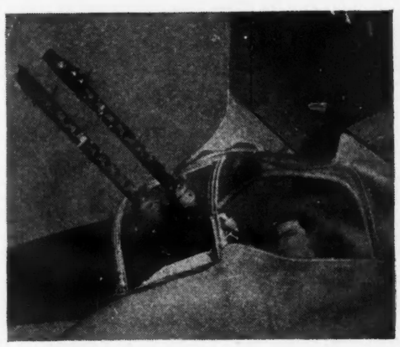
ON THE BOEING B-17G—latest version of the Flying Fortress—both the Sperry-designed top turret, built by Emerson and Steel Products, and the Sperry-designed belly turret, built by Briggs and Emerson, incorporate PLEXIGLAS advantages.





ON THE NORTH AMERICAN B-25—the famous Mitchell medium bomber—the top turret is designed and built by Bendix. Like so many other power turrets on America's best-known bombers, this turret is constructed of crystal-clear PLEXIGLAS.

ON THE MARTIN B-26 both the tail turret and the adaptable top turret—which fights not only on this plane but also on the Consolidated B-24—are made of PLEXIGLAS, to give clear, unobstructed vision to the gunners.



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Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries

Plastic Cover Protects Critical Parts in Process

WHAT is probably the first application in the aircraft industry of protective plastic covers for parts in process is now in use at the East Hartford plant of the Pratt & Whitney Aircraft Division, United Aircraft Corp. First part to receive the benefit of such a protector is a clutch drive shaft. Machined with splines on two of its dozen diameters, with two threaded sections and four micro-finished surfaces, this shaft was extremely susceptible to damage in process. Its largest diameter, nearly in the center, was prone to act as a wheel and consequently shafts rolled against each other at every opportunity, resulting in nicks and scratches. A study of various methods of protection led to the development of the new plastic container which is fitted after the heat-treat and finish-grind operations and guards the part as it progresses toward finished inspection.

Scrap material, laminated acetate plastic rejected by the Army as below specification for bomber use, is employed. The cover is produced in two sections, each molded to conform closely to the various diameters of the shaft and interlocking over the largest diameter. The ends extend far enough beyond the piece to protect it and are open to avoid condensation and consequent corrosion. Service life of the cover has not been determined as, so far, none has been worn out.

Regular use of the covers on this one item has resulted in reduction of scrapped shafts, saved many manhours of labor in rework, and has kept the flow of critical parts uninterrupted. Despite the relative weight of the shaft and the lightness of the plastic protector, it has been proved that the unit may be dropped from bench level to the factory floor numerous times without damaging either the part or the cover.

So satisfactory have been the results with this first cover, similar covers for four other shafts have been designed. A cap to protect threads of crankshaft bolts, with red and white ends to identify the right- and left-hand threads has been worked up and other casings are under way for highly finished plated and lead bearings. Of different material but stemming from the same investigation, tubes to protect the threads of lifting eyes, and also valves and knuckle pins are being developed of non-corrosive paper by Pratt & Whitney Aircraft.

Knife Sharpener as Metal Burring Tool

Workers at the Buffalo plants of the Curtiss-Wright Corp. have found the knife sharpener with roller disks a handy tool for trimming smooth the rough edges of metal sheet for P-40

fighters and Commando transport planes. A V-shaped metal guard has been added to protect the worker's fingers and a plastic handle to lessen fatigue. One of its advantages is that it clears both edges in one operation.

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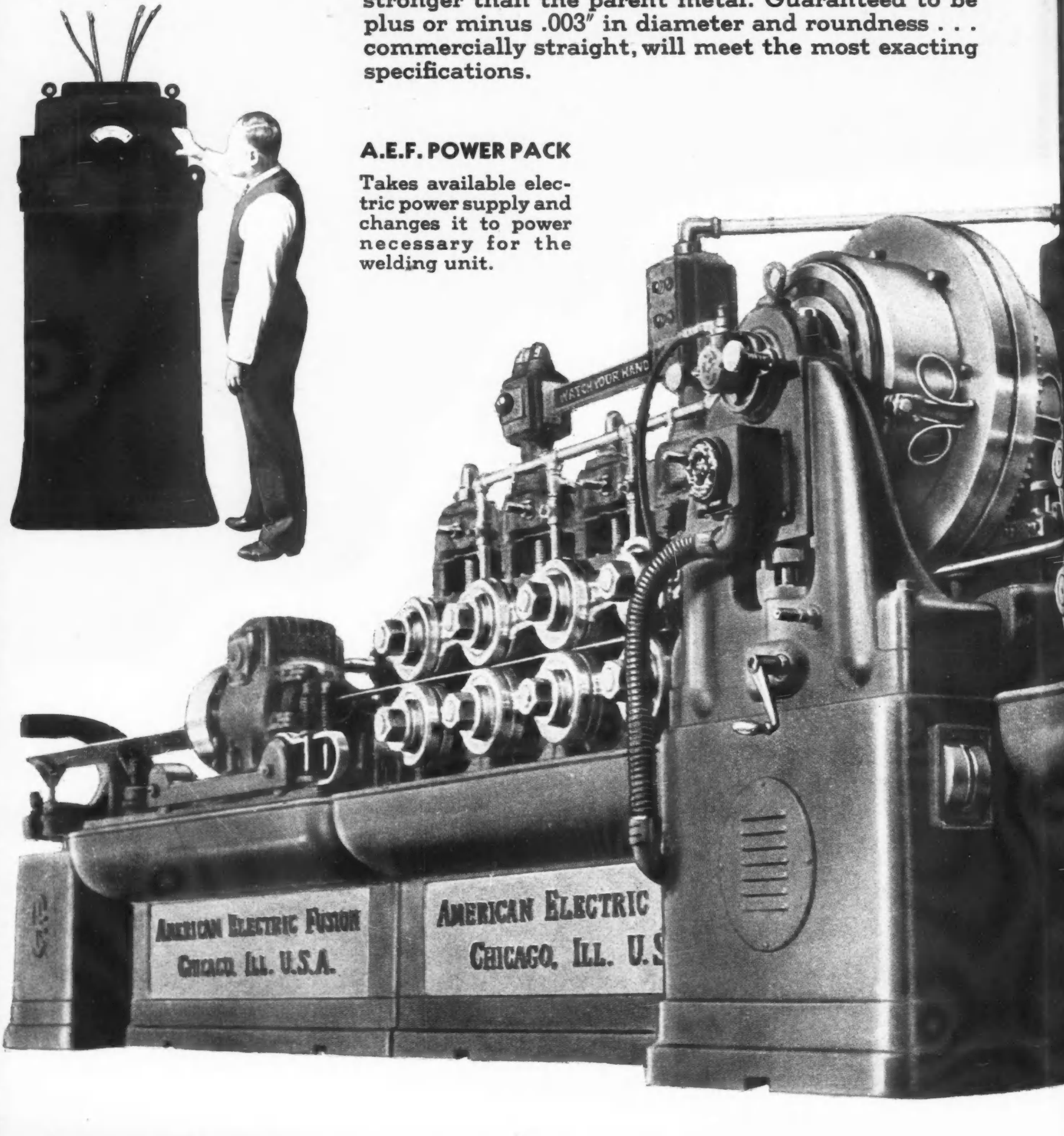
A COMPLETE TUBE MAKING UNIT

THE A. E. F. ELECTROWELD TUBE MILL is a fully automatic tube rolling and welding unit, which converts steel strip into perfect tubing with a weld stronger than the parent metal. Guaranteed to be plus or minus .003″ in diameter and roundness . . . commercially straight, will meet the most exacting specifications.

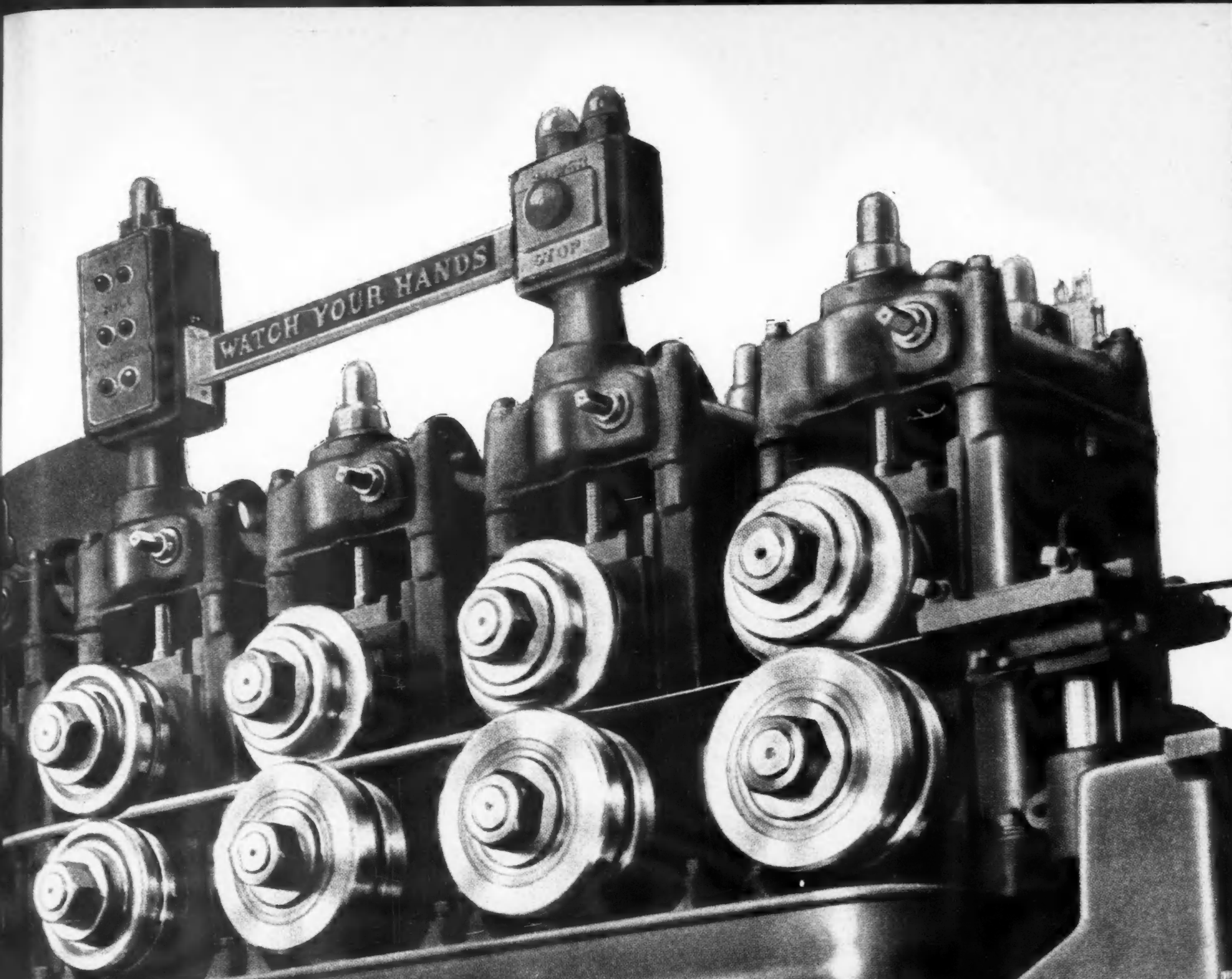


A.E.F. POWER PACK

Takes available electric power supply and changes it to power necessary for the welding unit.

One man is capable of operating entire Mill as WELDING . . . SCARFING . . . SIZING . . . STRAIGHTENING . . . and CUTTING to length is performed automatically.

The Tube Mill shown above is designed for continuous production at speeds up to sixty feet per minute producing tubing within the following limits:



Wall thickness, .025″ to .093″. Corresponding outside diameters, .500″ to 2.50″ O.D. Tolerance, plus or minus, .003″.

Two other types of Tube Mills are available. MEDIUM SIZE, wall thicknesses up to .1875″. Outside diameters from 1.5″ to 4″. HEAVY SIZE, wall thicknesses up to .250″. Outside diameters from 3″ to 6⅝″.

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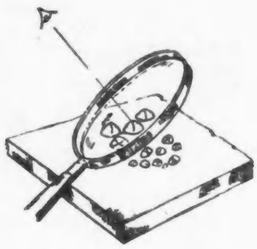
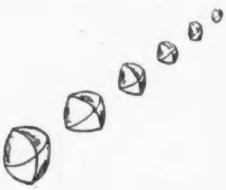
The Care of Industrial Diamonds

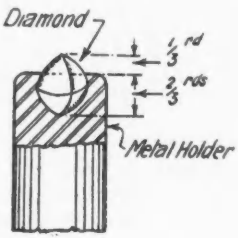
(From Industrial Diamond Review
(London)



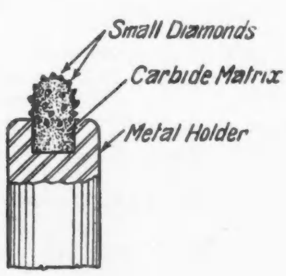
1—The diamond should be selected carefully, it should be as resistant to wear as possible and free from cracks.



2—The effectiveness depends largely upon the shape of the diamond. It should have many edges and points to allow for frequent re-setting. Octahedra with distinct points are preferred.

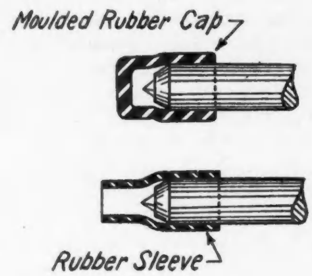


3—The diamond should be securely mounted and it must not become loose by vibrations during the truing process. It is usual to embed two-thirds of the diamond in the metal holder.



4—The size of the diamond should be in proportion to the size of the grinding wheel, its hardness and grain size. In general, large diamonds are more economical. For some purposes, however, a modern tool consisting of many small diamonds, set in a metallic matrix may prove to be of better value. The diamonds of these tools cannot be reset.

5—The diamond should be protected against accidental blows when the tool is not in use. A short length of rubber tubing may serve as a protecting sleeve.



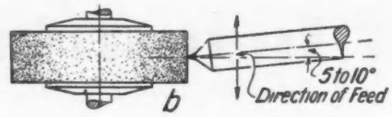
6—Frequent truing of the Grinding Wheels causes little strain on the diamond and is economical in the use of Grinding Wheels, because only small irregularities in the wheels are to be corrected.

(*Turn to next page, please*)

7—The truing device must be rigid and the truing tool properly supported to avoid vibration.

8—Diamond cuts should not be deeper than 0.001 in. and hard pressure in feeding across the wheel must be avoided. As a rule, wheels should be trued at their proper grinding speed. Large diameter wheels and thread grinding wheels require reduction of speed during the truing process.

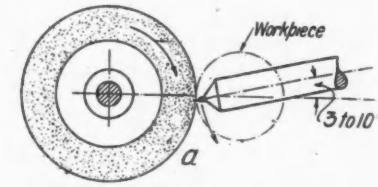
9—The diamond should be passed slowly across the face of the wheel for high finish, and rapidly for stock



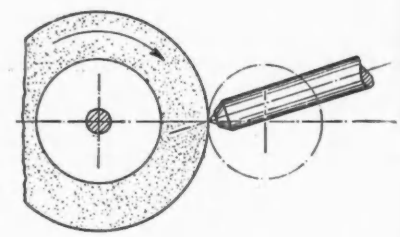
removal. Truing of the periphery of a grinding wheel should always start at the middle, as the corners are often worn smaller.

10—Plenty of coolant should be used during truing. Where a coolant cannot be used, frequent cooling periods should be allowed for. A hot diamond should never be cooled off quickly.

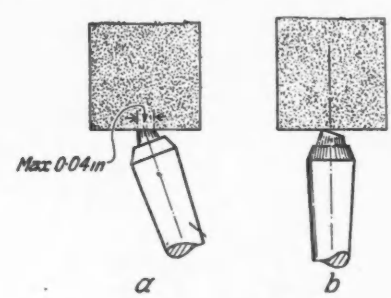
11—The diamond shank should always be slightly inclined towards the wheel, pointing in the direction of the grinding wheel rotation (drag angle).



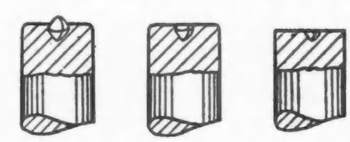
Usually the point of the diamond should touch the grinding wheel slightly below the centre.



12—If difficulties still arise the point may touch the wheel at the centre line; in no circumstances above centre.



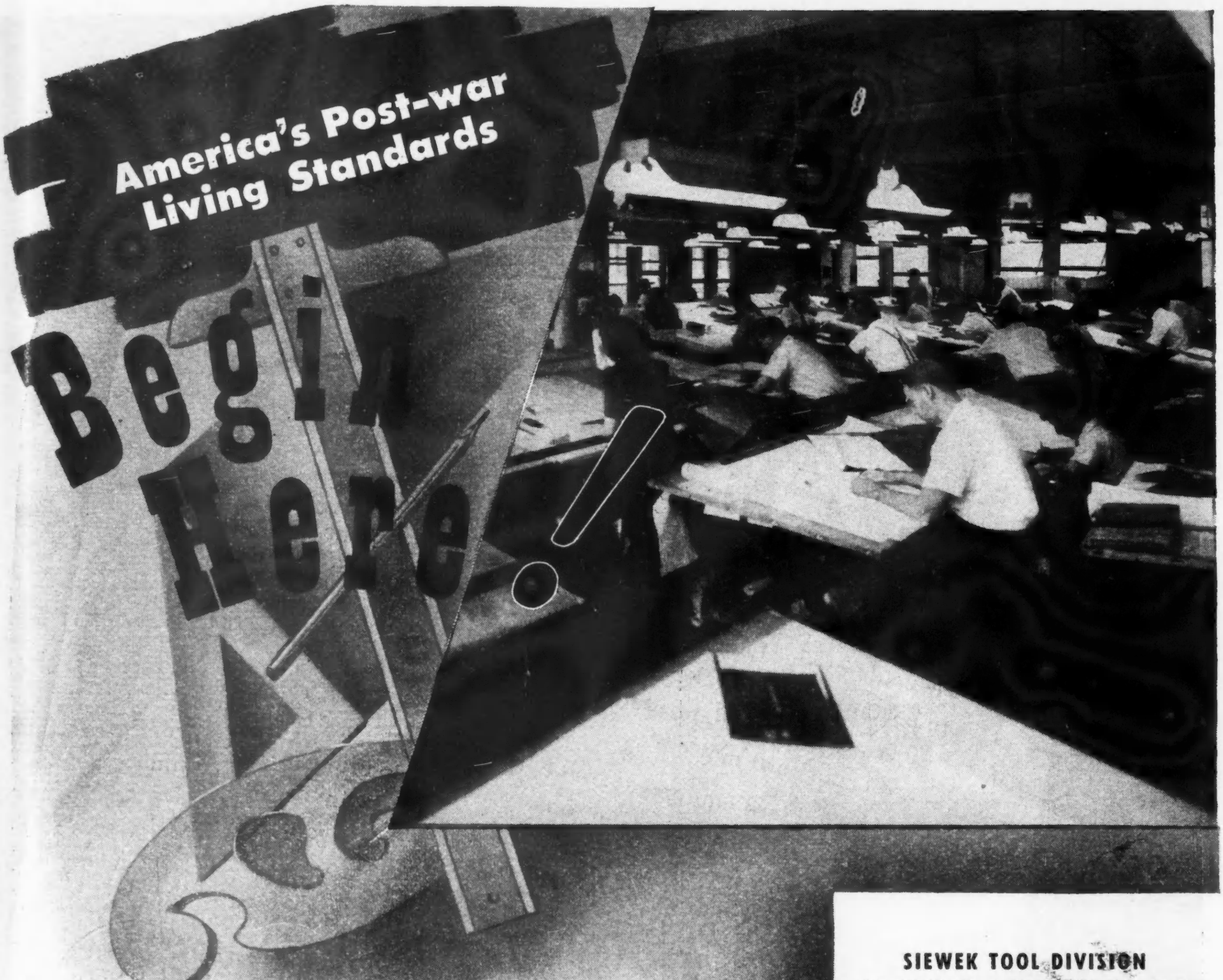
13—The diamond should be frequently turned to ensure continual sharp points and regular wear. When a flat is worn (a), the diamond has to be turned into position (b).



a b c

14—When the diamond (a) has worn down to the setting (b), it has to be reset. In no circumstances should the setting be ground away (c).

This issue of AUTOMOTIVE *and* AVIATION INDUSTRIES contains valuable data for twelve months of handy reference



● No matter if your post-war planning is still to be started, in the idea stage, or anywhere along the line towards finished product—Siewek Engineering Division is able to step in and carry on for you.

Manufacturers, thinking now in terms of better post-war products, are turning to Siewek for practical development work—easing the strain on their own engineering departments. Siewek's highly skilled engineers and experienced tool designers will work with your staff to develop the idea and the product, or design and build special machines and tools to manufacture it.

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Here's the Post-War Brake ... it
HARNESSES MOMENTUM
● Illustrated here is the action of the energizing elements of the Lambert Disc Brake. It is this action which is so important to the brake's efficiency and superiority ... its greater safety ... softer pedal ... and equal effectiveness in stopping backward or forward motion.
As a standard equipment brake, the Lambert Disc Brake has already proven a distinct, revolutionary advance in brake performance. It's ready now for your engineering department's investigation and tests. Auto Specialties Mfg. Co., St. Joseph, Michigan.
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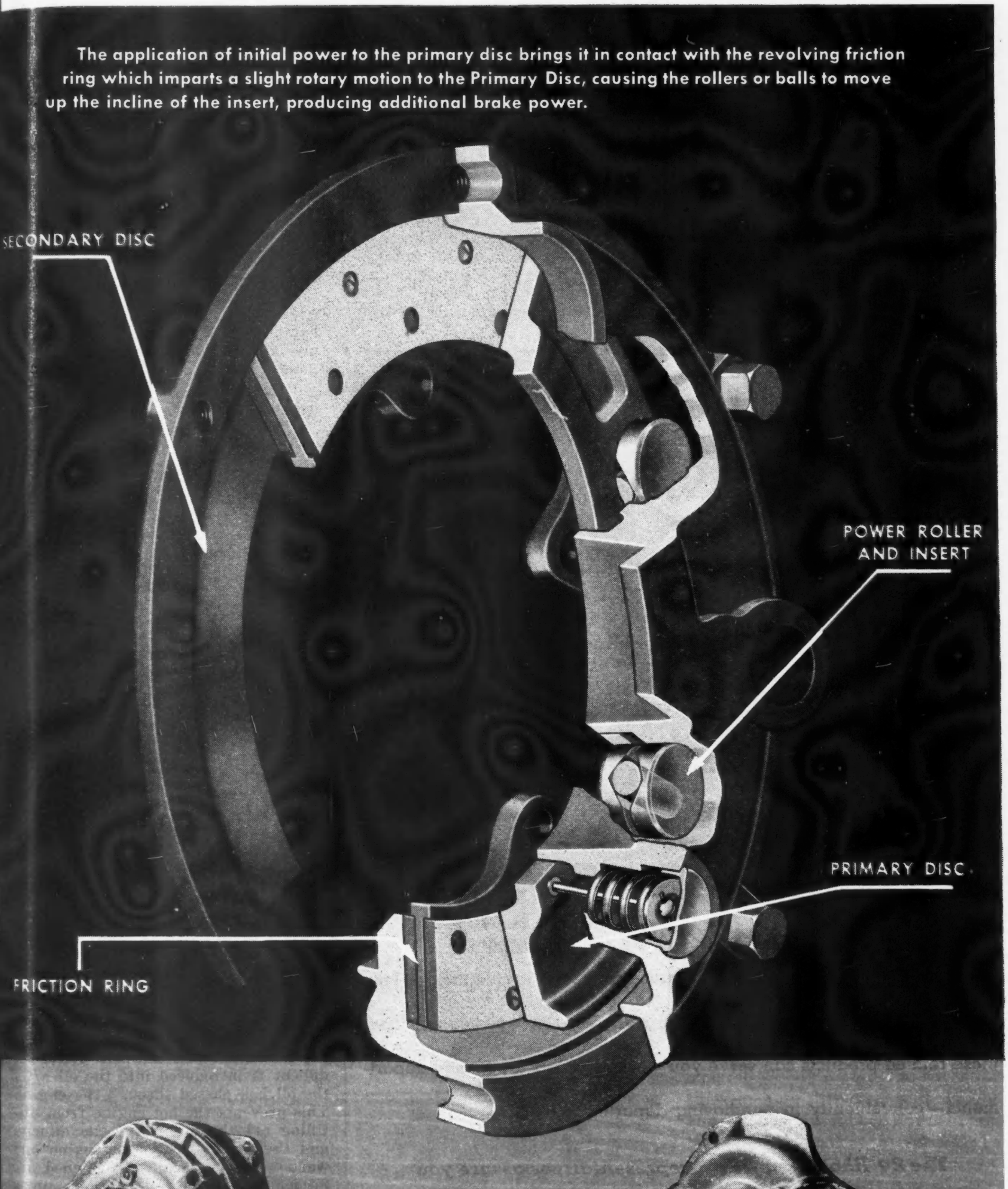
TRACTOR HYDRAULIC

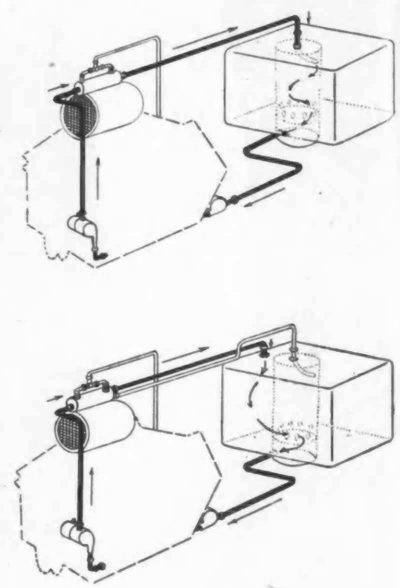

The application of initial power to the primary disc brings it in contact with the revolving friction ring which imparts a slight rotary motion to the Primary Disc, causing the rollers or balls to move up the incline of the insert, producing additional brake power.
SECONDARY DISC
POWER ROLLER AND INSERT
PRIMARY DISC
FRICTION RING
MECHANICAL (AXLE TYPE)
MECHANICAL (COUNTERSHAFT TYPE)

New Cold Weather Lubrication System

A NEW cold weather lubrication system for aircraft engines and adaptable to all types of internal combustion engines has been devised by Leslie T. Miller, Glenn L. Martin Co. engineer. The new development consists of a series of basic improvements on the method of diluting lubricating oil with gasoline in order to produce quick starting of aircraft engines in cold weather.

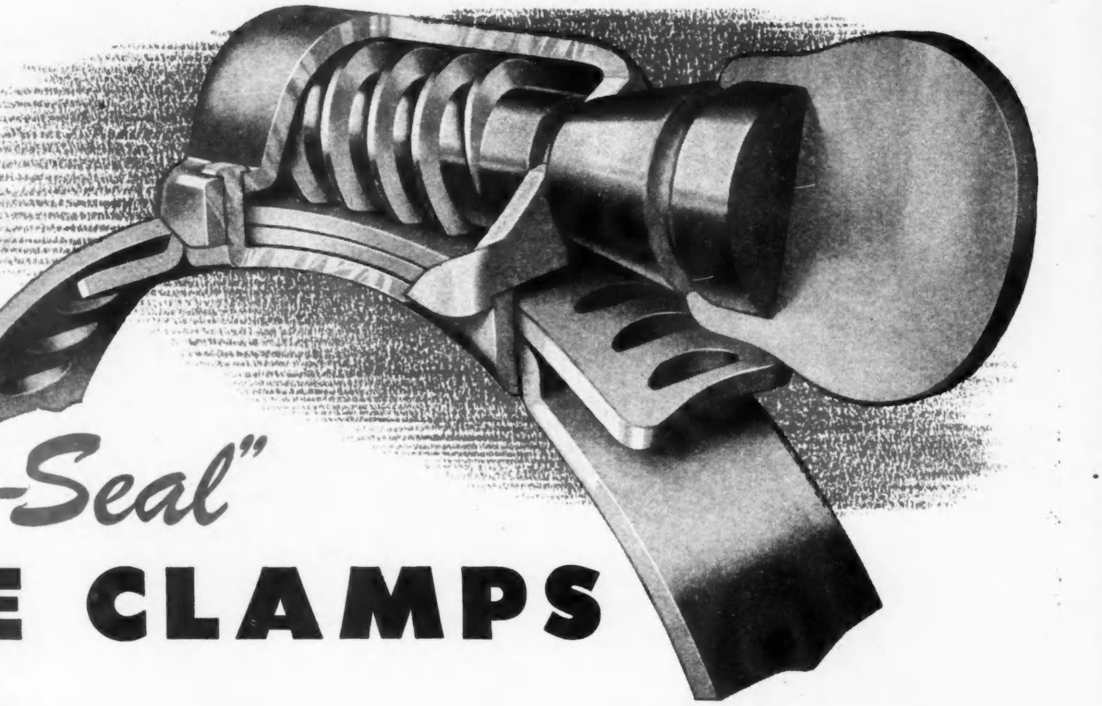
Each engine of an airplane has its own reservoir of lubricating oil holding as much as a hundred gallons. When the engine is running, oil leaves a warm-up compartment within the reservoir, passes along a pipe line into the engine, leaves the engine to pass through an air-cooler, and from there returns to the warm-up compartment. Under the unimproved method, a pilot after landing in cold weather presses a button which introduces gasoline into the oil before it enters the engine, and assumes that when he wants to take off some hours later the warm-up compartment, the engine, and all oil lines will contain a thinned supply of lubricant. What sometimes happens, however, is this: The diluent, being introduced *before* the oil enters the engine is partially evaporated out in the hot engine. The result is that completely thinned oil is left only in that part of the line between the point where the diluent is introduced and the engine itself. When he goes to take off some hours later, the pilot may find that while he has perhaps enough thinned oil to start with, the rest of the system is jammed with slugs of thick oil which are apt to burst the air-cooler. An added tragedy is that the plane is usually off the ground by the time the air-cooler bursts, with the result that the oil supply fails, the engines burn out, and the plane crashes.

The new method, which has proved itself on warfronts where planes must



Improved method of diluting oil in lubrication system of aircraft engines as installed in Army (upper drawing) and Navy (lower drawing) planes.

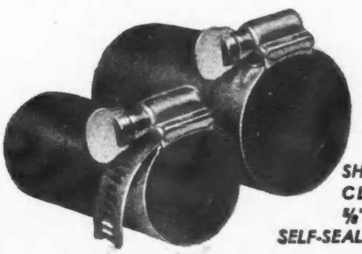
take off within seconds after standing for hours in bitter cold, disposes of these dangers. In the first place, the diluent is introduced into the oil *after* the oil has passed through the engine. This prevents the hot engine from distilling out the highly volatile diluent, and thus leaves the lines, engine and warm-up chamber full of thinned oil. Secondly, the new method sets up a by-pass which keeps cold and hard oil from getting into the air-cooler and bursting it. In the third place, the new method permits the use of dual return lines to the oil reservoir—one leading into the warm-up chamber and the other into the reservoir as a whole. A thermostat located at the point where the diluent enters the oil either by-passes the oil around the cooler or returns it to the warm-up compartment or to the reservoir. Operation of the new method is shown in the accompanying illustrations.



"Aero-Seal"

HOSE CLAMPS

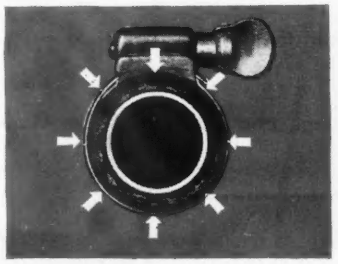
- HIGH STRENGTH.
- UNIFORM PERIPHERAL TIGHTENING.
- NO LEAKAGE UNDER HIGH PRESSURES.
- SELF-LOCKING, NO LOCK WIRE NEEDED.
- NO LOOSE PARTS.
- CAN BE RE-USED.
- WILL NOT DISTORT OR COLLAPSE THIN-WALL TUBING.
- CAN BE PUT ON HOSE IN PLACE.
- COMPACT HOUSING DESIGN.
- 16 SIZES FOR 1/4" TO 4" I.D. HOSE.
- EXTRA LONG TAKE-UP.



SHOWS M-20 CLAMP ON 5/8" AND 1" SELF-SEALING HOSE

WORM GEAR ACTION. The break-away picture above shows the AERO-SEAL action . . . a heat-treated worm which engages slots in the spring steel band, the slots corresponding to teeth of a worm gear. This gives a belt-like tightening action which assures uniform pressure (see lower picture) around the entire periphery. Hand-tightening with the thumb-screw meets maximum pressure requirements. The screw will hold tight *without lock wire* under severe vibration, as proved in authoritative tests.

RE-USABLE. AERO-SEAL Hose Clamps can be put on, and taken off, hose in place on tubing by simply backing the band out of the housing and springing it open, as shown here (except with the smallest sizes). Since no cutting or folding of the band, or disturbance of any other parts of the clamp, takes place, the AERO-SEAL clamp may be removed and replaced, or used on another hose, as many times as necessary. There are no loose pieces to fall off, screw out, or be lost.



LONG TAKE-UP. AERO-SEAL Hose Clamps have *more than double* the diametral take-up required to cover variations in hose diameter, wall thickness, and the flow of rubber under repeated tightening of clamps in service. Each size of AERO-SEAL Hose Clamp can be used on several smaller sizes of hose by simply taking up the band, thus permitting substitution of a larger size clamp when the recommended size to fit a given hose is not available. *Write for samples.*

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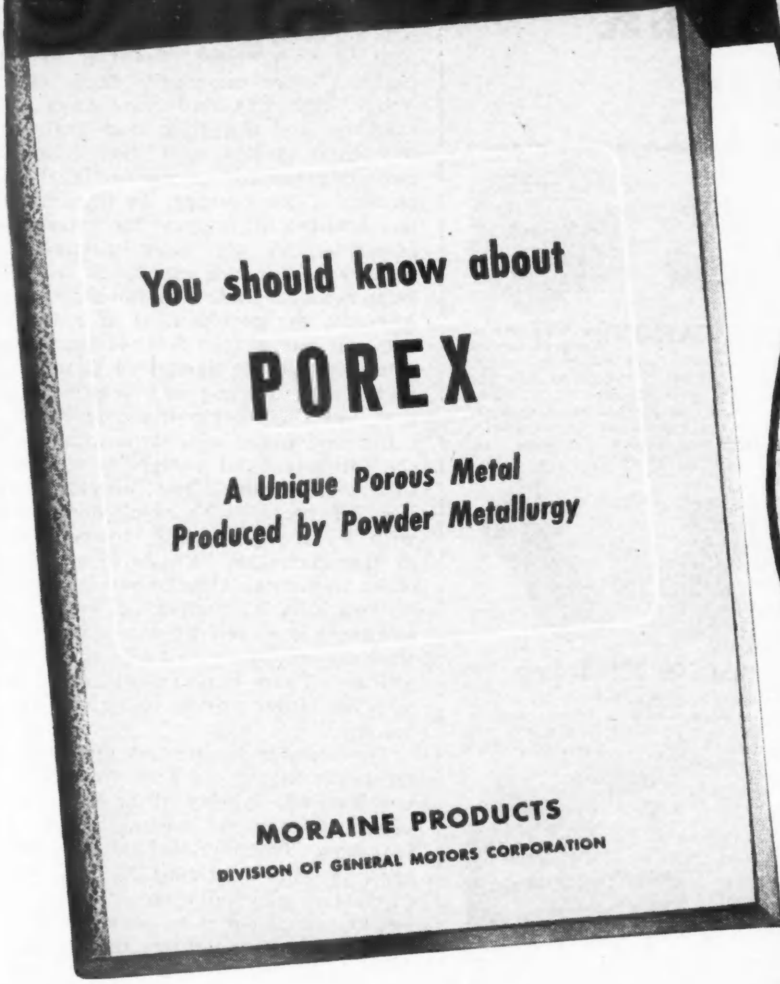

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Enterprise—The Foundation of Employment

By **H. G. Welsford**, Vice President, Dominion Engineering Works, Ltd.

THE objective of all economic activity is the ultimate acquisition by the consumer of something that satisfies his wants. But consumer expenditure itself has seldom if ever required stimulation when the people, through useful employment and trade, have money to spend. Where does this money come from? Income results only from expenditure made by someone else. It is estimated that in peacetime about 45 per cent of all those employed in manufacturing and distributive industries derive their employment directly or indirectly from expenditures for capital goods. Competent authorities in Great Britain and the United States, and the James Committee in Canada, estimate that something between 18 per cent and 25 per cent of the total national income must be spent each year for new capital investments in order to sustain full employment. It was this 45 per cent group of workers in the capital goods and construction industries which suffered most from unemployment during the depression of the 1930's.

There is no other sound and constructive way in which a high level of expenditure can be initiated and maintained except through the investment of substantial amounts of capital for the expansion and development of our industries. We have only to look at the tremendous expansion of our population and industry which has taken place on the North American Continent during the last 150 years to appreciate how much has been invested in improved means of production and distribution, and what this investment has meant to us in terms of employment and better standards of living. The employment which has produced this tremendous development has not been initiated in the first instance merely by meeting the day-to-day demands of consumers. Only a minor part has resulted from expenditures initiated by government, and this principally for such community facilities as public highways and waterways and facilities for education and training. Municipal development has followed and not preceded the commercial development of the country. In the main it has resulted solely from the enterprise of individuals who have initiated expenditures for the expansion and development of trade and industry. For example, the development of railways and the automobile did not begin because the people demanded something better than a horse and buggy. They both had their beginning only because a few individuals and corporations had the initiative and enterprise to make expenditures which have provided millions of people with employment and with a more useful and cheaper mode of transportation. Employment in all other industries throughout the country has been initiated in the same way and there is no doubt that we must continue to depend upon it for our future welfare. There is no such thing as enterprise, either private or public, without it.

The history of this Continent up to the beginning of the First World War has been one largely of an expanding population and the opening up of new frontiers. There undoubtedly is much room on this Continent for a further expansion of population and industry but an expansion is no longer possible based upon extending the frontier which now exists only to the north. Therefore, broadly speaking, the industrial problem on this Continent has changed to one of expansion of industry through a more intensive development and cultivation of what we already have, rather than expansion of the kind which took place during the country's pioneer period.

In order to understand this problem clearly, it is useful to distinguish between an expansion of industry which aims at an expansion of production to meet an increased demand which might result from an increase in population

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(*Continued from page 268*)
or the opening of new territories in the market, and one which aims at increased production resulting from the development and use of a more efficient technique such as will assure that the increased production can be consumed by the same population at lower prices. There are obvious limitations to an expansion of the first type, but the possibilities for the development of our industries as a means of providing increased production and a high level of employment by the use of improved facilities of production and distribution, are almost unlimited. The latter, therefore, is of much greater importance than the former, and becomes of increasing importance as opportunities for expansion of population and the opening up of new territories decline.

A large proportion of the industrial and distributive equipment in use today is obsolete, and inefficient by modern standards. On the other hand, some of our industries have furnished outstanding examples of what can be accomplished by a positive and aggressive policy of development of its products and its production technique through the use of improved equipment. The automobile industry is an example of one which has pursued a policy of ruthlessly scrapping their existing equipment, regardless of its age, when new equipment could be purchased which would enable them to sell better automobiles at a lower price and, therefore, enlarge their market. By this policy they not only increased production and employment in their own industry, but their expenditures for new equipment and materials indirectly provided much additional employment in others. The more employment opportunities that are needed, the more necessary it is that industry must initiate capital expenditures for development of this kind.

The replacement of obsolete equipment is a most important factor in the capital expenditures of industry. The rapid rate of obsolescence of industrial equipment is not widely appreciated. In many industries the effective life of equipment runs only from five to ten years. It is not dependent upon the development of new industries, the opportunities for which are by no means constant. A policy of replacement expenditure by industry can be so planned as to provide relatively stable expenditures from year to year and thereby contribute to greater security of employment.

Where will the money come from to support a high level of expenditure for the development of industry which will support a high level of employment with assurance of its continuation? Most of the money must be furnished by industry itself from the reserves which it has set aside out of its earnings. Every well-conducted business sets aside each year a depreciation reserve for the replacement of its fixed assets. An allowance for depreciation is permitted as a deduction from earnings before the payment of income tax. Many industrial managers have not fully realized the real purpose and importance of depreciation reserves in relation to their own business or in relation to the public welfare. They seldom bear any relation to the annual expenditures of the business for the replacement and improvement of its fixed assets. Funds set aside out of earnings for depreciation have been regarded merely as working capital and used for the general purposes of the business, which might be inventories, the purchase of new properties, the retirement of bonded debt, and even operating losses. Some regard depreciation reserves as a return of capital to the shareholders, and consider it unnecessary to use such reserves for the replacement of its assets so long as they are being maintained in a good state of repair out of current operating revenues. They take pride in the fact that their fixed assets are largely or completely written off. Such a policy fails to recognize that the only really important factor in depreciation is obsolescence. The time inevitably comes when such businesses are no longer competitive and drift towards eventual insolvency from which they never recover unless the real facts of depreciation are recognized and obsolete assets are re-

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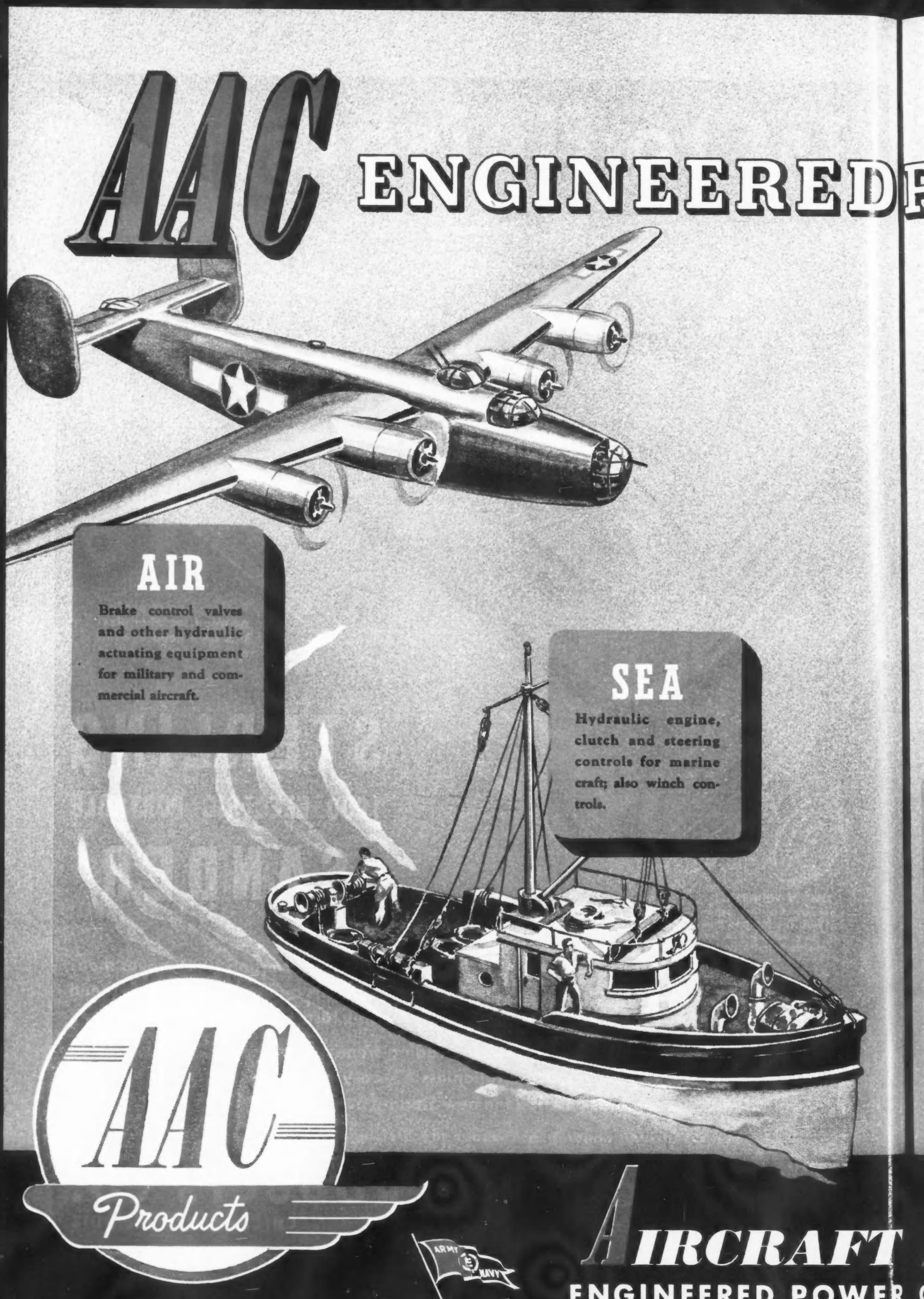
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(*Continued from page* 270)

placed. There has never been a sound and uniform policy exercised throughout industry as a whole of utilizing depreciation reserves for the purpose for which they have been set aside.

The use of such reserves is a sound basis for a definite post-war policy and plan for industry which, if generally adopted, will be the means of attaining a sufficiently high level of expenditure by private enterprise to maintain a high level of employment after the war. If industry will say to its employees—"We propose to carry out, as soon as a fall in the requirements of war production permits, a definite plan of expenditure for the improvement of our buildings and facilities, equal at least to the depreciation reserves which we set aside each year out of our earnings. We will spread these expenditures over a period of, say, five years at as uniform a rate as possible, in order that a steady level of employment and income will be maintained over this period. When this five-year period is over, we can then make similar plans for further periods, in order to assure the greatest degree of employment security for the future."

The interest of joint management-labor committees, where these exist, could be sought to give practical effect to a policy of expenditure along these lines, and to seek the confidence and cooperation of employees in the future of their company and in their own future security and welfare through the development of private enterprise.

The basis of prosperity is production, and to expand production requires capital, which is derived from surplus earnings. If the government continues to take away from industry by taxes too large a share of these earnings, and at the same time does not permit sufficient deductions to be made from income before taxes to provide for depreciation and obsolescence and other normal contingencies, then we cannot expect an expanded production. The capital which should be used for this purpose will be in the hands of the government. The primary objective of the government should be to encourage industry to expand production by encouraging capital expenditures. Therefore, underlying all post-war plans for increased employment, there must be revisions in our taxation structure and public policies which will encourage thrift and the conversion of savings into capital investment through private enterprise. There must also be an assurance to those who save and invest that there will be stability in the exchange value of their savings. The importance of this cannot be over-emphasized. During the depression period preceding this war, a considerable part of our savings was expended for the relief of unemployment without a corresponding increase in production, and during the war we have consumed a large part of our savings in paying for war materials intended for destruction. These savings have been consumed

through public expenditures, which have added enormously to our public debt. Like any other kind of indebtedness, the capital we have consumed can only be replaced by working harder and by sacrificing and saving from our future production. We cannot avoid this merely by levying taxation upon those who have loaned us their money or by taxing those who earn income through the investment of their past savings. This has not even been avoided in Russia, where they repudiated all their public debt and wiped out all private savings and investment, by instituting a complete system of state capitalism. The people of Russia, down to the lowest paid worker, have been compelled by state policy and plans to sacrifice and save in order to provide the substantial amounts of capital required for the expansion and development of their industries, and they have no individual freedom of choice about the matter. Neither is it possible to replace the capital we have consumed by reducing the hours of work or by other restrictions upon work such as have been publicly advocated by organized labor. We can only make the burden of our public indebtedness lighter by increasing our productive efficiency and our total production to the highest levels possible.

Air and Surface Transport Costs

By **Edward Warner**, Vice Chairman, Civil Aeronautics Board*

IN THE period immediately before the war, the cost of air transport operation in the United States, with mixed passenger and cargo loads, averaged about 27 cents per payload-capacity ton-mile. The corresponding figure for motor buses was about seven cents per payload-capacity ton-mile; for the most efficient vehicles for the carriage of cargo on the highway it averaged about three cents; and for the carriage of freight by railway it was still less. All of these figures include depreciation and overhead and administrative expense, and all taxes except the Federal income tax.

Before considering the effect of that substantial gap in cost between air and surface transport, and considering how far the gap can be closed, consider how far it has already been narrowed. In 1929 the average total cost of operating the best commercial transport then available, the then ubiquitous Ford, was about 45 cents per payload-capacity ton-mile. In 1933 the Fords were being succeeded by the 10-passenger Boeing monoplanes, and cost per ton-mile was down to about 36 cents. In round numbers the unit cost had been reduced a fifth in four years, and it was reduced by another quarter in the succeeding four, up to the time of the general introduction of the DC-3. Costs will need to undergo a substantial further reduction before really heavy inroads into the present freight loads of truck, railway, or vessel can be expected. There are many articles of commerce for which speed of transportation is highly desirable, but there are relatively few for which speed is of such importance as to support a quintupling of transportation costs.

Taking the various possibilities together (increase of plane size, empty weight saving, aerodynamic gains, reduction of overhead expense of airline operations, etc.), there is every hope that within three or four years after the end of the war the cost of operating with mixed loads of passengers and cargo will be reduced from the pre-war figure of about 27 cents per payload-capacity ton-mile to something around 18, and that the corresponding figure for operation with cargo alone will be brought as low as 10 or 11 cents. Allowing for the impossibility of maintaining such load factors in peace as have been built up in war, and for a normal operating profit, the estimates would correspond to passenger fares of about three cents a mile, and air cargo

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* This article comprises extracts from the address, "Air Transportation Prospects", given by Mr. Warner before the Engineering Society of Detroit on Dec. 15, 1943.

rates, exclusive of pick-up and delivery charges, of about 16 cents a ton-mile. These figures are not presented as probabilities for the month after fighting stops, but as likely to be attainable after operating conditions have been reasonably stabilized, and after some additional operating experience has been secured under peaceful conditions, and after the manufacturing industry has had time to market new aircraft of postwar design.

The spread between even the lowest of these figures and the present cost of moving goods by surface vehicles is still large; yet it sometimes seems that the smooth and boundless air space ought to furnish the most economical transportation. To show what specific factors make it more costly than its surface rivals, it is interesting to make a point-by-point comparison between the average cost of operating a DC-3 airplane, of 21-passenger capacity, and the national average for intercity motor buses of about 50 per cent more seating capacity than the airplane, as shown by reports to the Civil Aeronautics Board and the Interstate Commerce Commission, respectively. Available data permit closer parallels between the passenger airplane and the bus than between a cargo airplane and a truck; but the general results of a similar comparison in the latter case probably would not be very different. The buses were showing, immediately before the war, an average operating cost of almost exactly 20 cents per mile. The corresponding figure for the DC-3 was about 68 cents per mile. Passengers by bus carry less baggage than those by air; and the airplane, unlike the bus, carries mail and express together with the passengers. The total effect is to make the payload capacities of the two vehicles virtually the same; and the ton-mile cost of the airplane is therefore about three and a half times that for the bus. A few comparable items of expense are:

	Cents per mile	
	Airplane	Bus
Fuel and oil (including fuel taxes)	8.56	2.58
Pay of crew	9.63	3.58
Maintenance of equipment (including maintenance overhead)	9.80	3.60
Station expense (including meteorologists, radio operators, etc.)	13.19	2.38
Insurance and accident costs	2.29	1.05
Traffic solicitation and advertising	8.39	0.96
Depreciation of equipment	5.04	2.03
Pay of general office employees, including executives	1.79	1.00
Taxation and licenses (excluding fuel taxes)	1.41	1.40
Passenger service cost (exclusive of pay of crew and of liability insurance*)	3.42	...

* Not separately identified in Interstate Commerce Commission reports, but certainly very small as the item is defined in airline practice.

The blame for the cost differential between air and surface transport is widely diffused. Among the items

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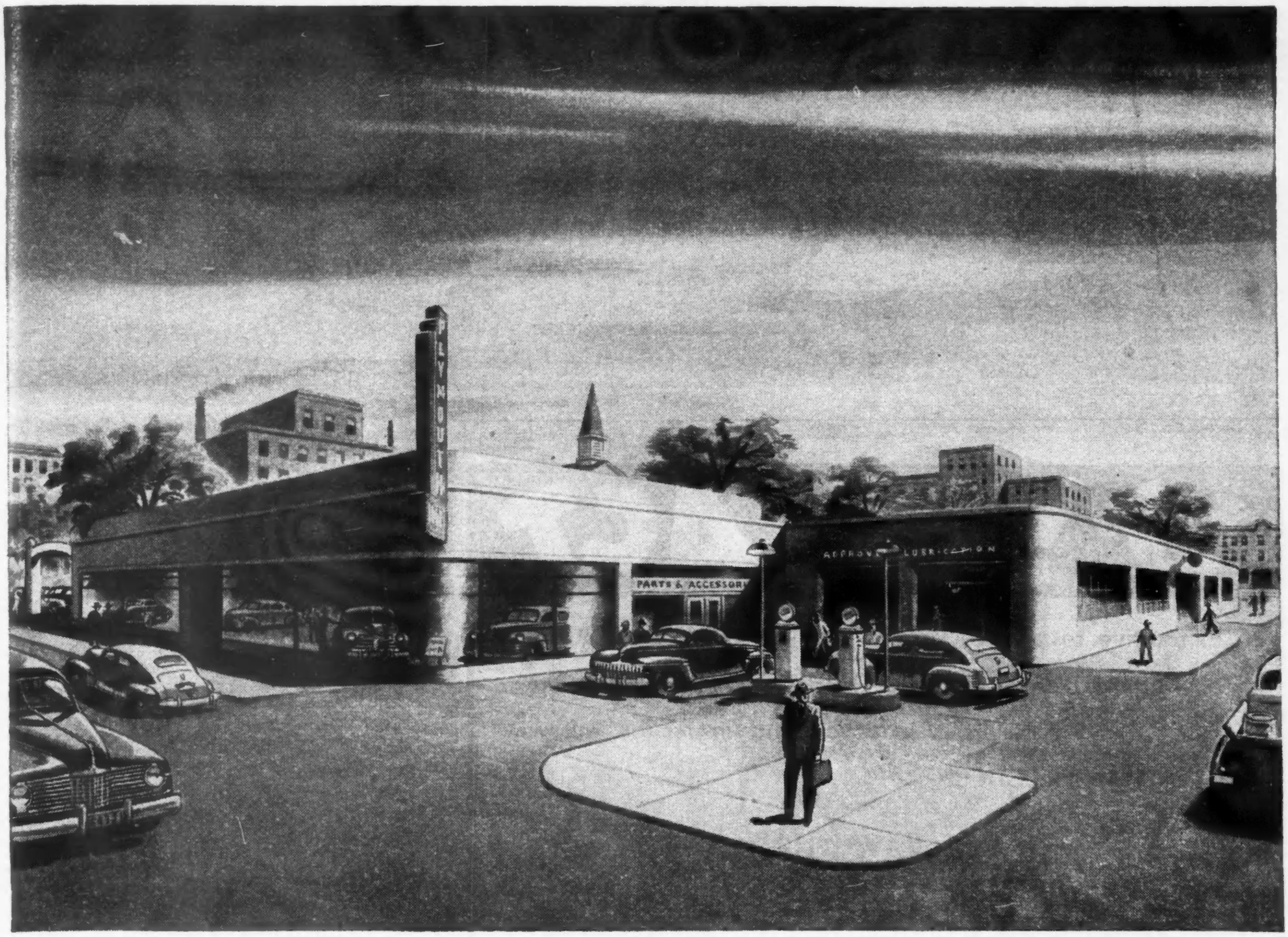

Once upon a lot of times . . .

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These are stories of the American way of working, in which men are free to take advantage of the openings ahead of them and to progress as far as their beliefs, desires and industriousness can take them.

By better serving the needs of their customers they built their businesses from sometimes small beginnings into substantial and thriving enterprises. In the process they provided employment opportunities for other men and women and contributed to the economic life of their communities.

Under America's traditional freedom of competitive individual enterprise, broad opportunities should continue to exist in the automobile business for ambitious, energetic business men.

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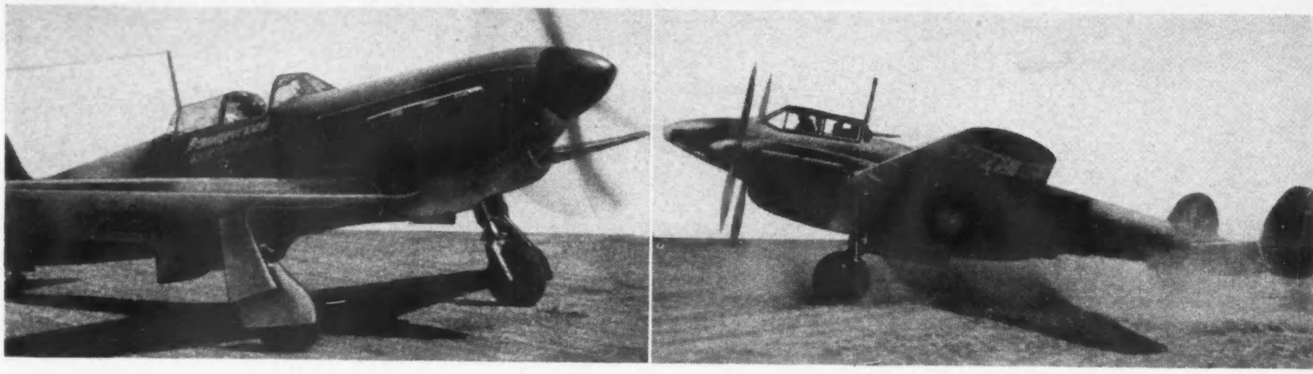

(Left) Yak-9 fighter. (Right) Petlyakov-2 dive bomber leaving on an assignment.

New Permanent Magnet Alloys for Instruments

The new permanent magnet alloys that have been developed for small panel-type instruments increase their sensitivity beyond that of the chrome and tungsten alloys steels previously used for permanent magnets, according to M. S. Wilson and J. M. Whittenton, engineers in the Electrical Instrument Section of General Electric's East Lynn Works. For the past 15 to 20 years, cobalt steel permanent magnets have been used in instruments, providing a means of producing higher sensitivities. This material has been used in forged and cast forms and is most attractive from the standpoint of high coercive force of about 210 with total energy of 900,000. However, its inherent high cost limits its use primarily to the higher sensitivity instruments where the chrome and tungsten steels are unsatisfactory. Great advances have been made recently in strength of permanent magnet materials by the development of the aluminum-nickel-cobalt iron (alnico) alloys. They have been widely used as instrument magnets and their manufacture may be carried out by either of two methods—the sintering process or casting.

The ideal magnet from the standpoint of the instrument designer would be one having high coercive force, residual induction and available energy, and which had good machining and fabricating qualities. An approach to this ideal has been made in the cobalt-molybdenum-iron alloys more commonly known as "comol." Comol, whose typical composition is 12 per cent cobalt, 17 per cent molybdenum, balance iron, contains a minimum of the critical metals; it can be easily cast, and when properly heat treated, can be readily drilled, milled and machined. A coercive force of about 245 is obtained as compared with 210 for 3 per cent cobalt with a residual induction of 10,300, higher than either 36 per cent cobalt or alnico II, and a maximum energy value of 1,100,000 as compared with 930,000 for 36 per cent cobalt and 1,650,000 for alnico II.

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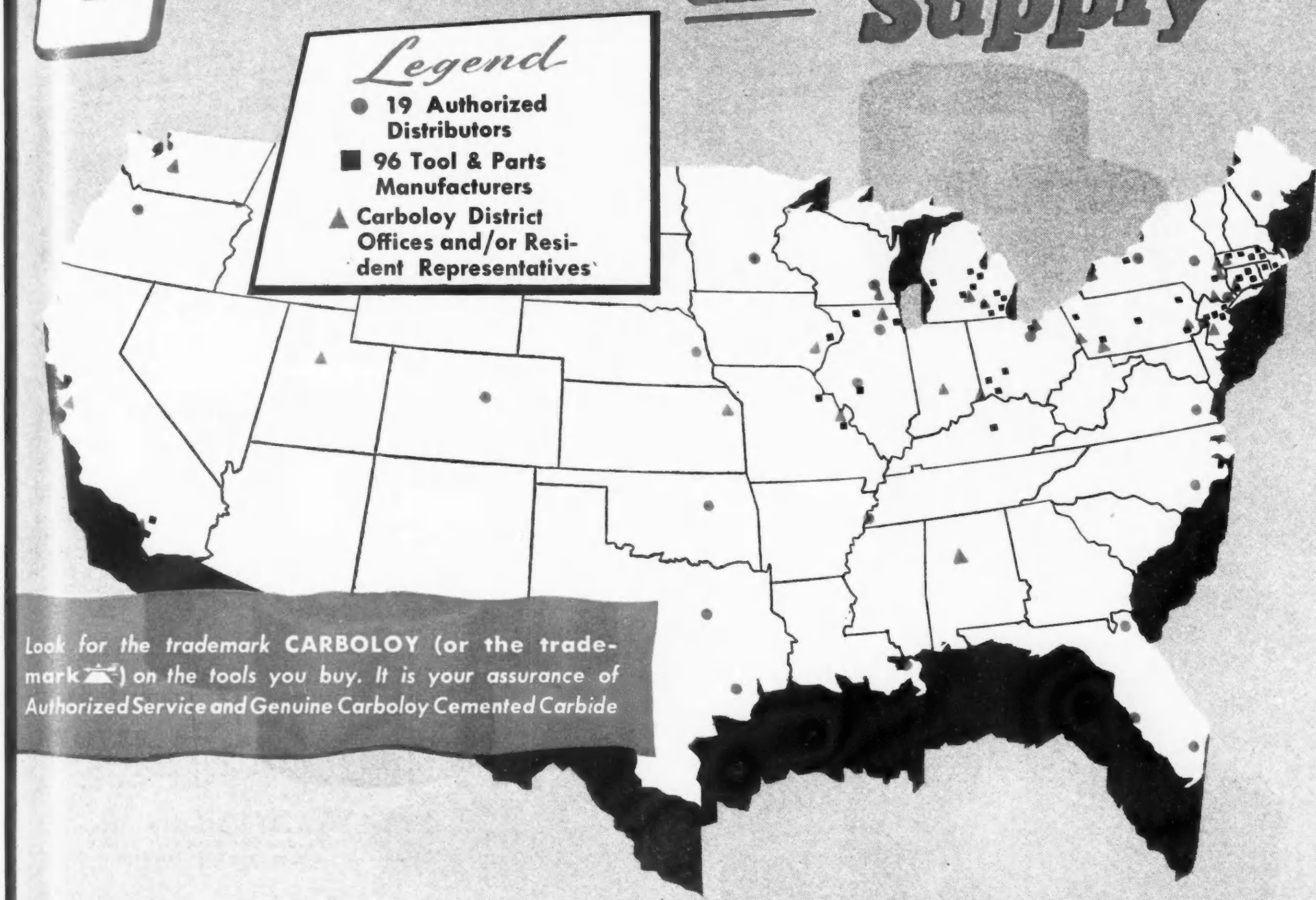
Coast to Coast Service and Supply



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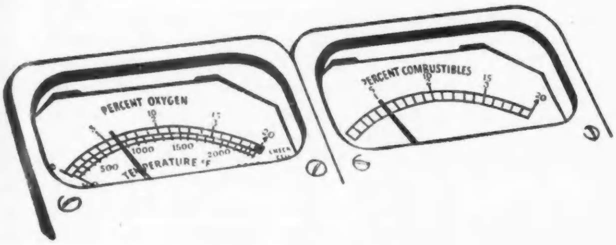
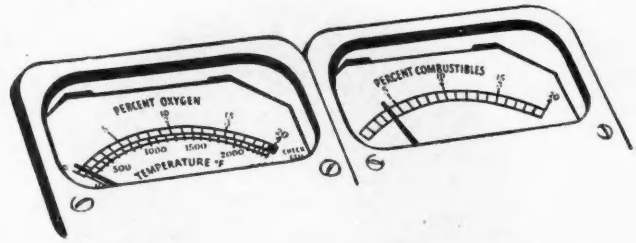
How to Control Furnace Atmosphere



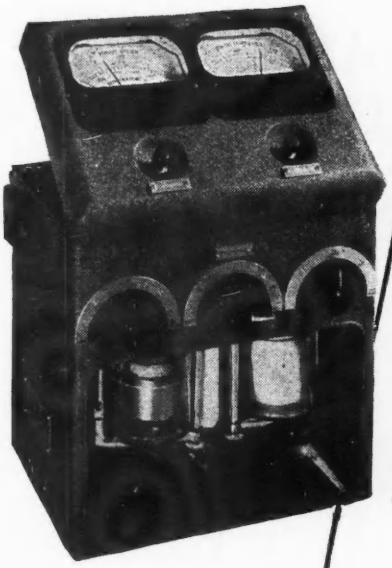
Make this Test

Have a Cities Service Engineer, with the aid of the Industrial Heat Prover, take a test reading* of any combustion equipment in your plant. Note percentage of needless excess oxygen in the furnace atmosphere as registered on the Heat Prover dials.

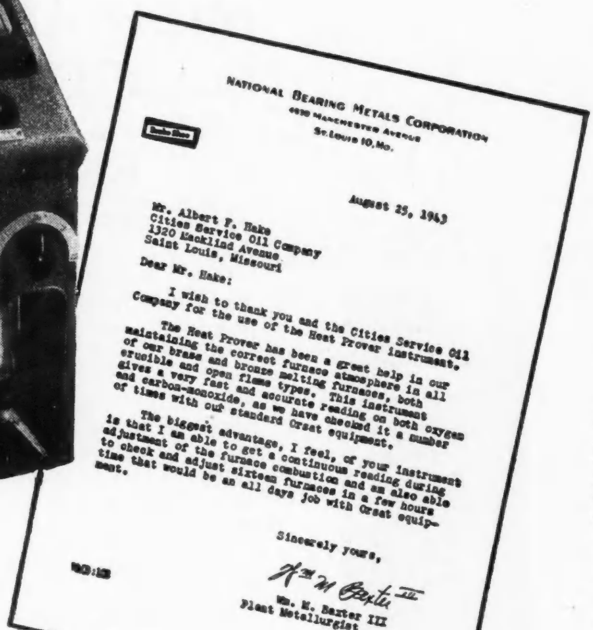


See the Results

The Cities Service Engineer may then evaluate the Heat Prover analysis against his data and curve charts which are the Standard of Efficiency for the particular equipment . . . and make recommendations for correcting the defect—which in this case would reduce excess oxygen to ½%.



THE CITIES SERVICE HEAT PROVER reveals the degree of waste caused by air deficiency (excess fuel), or the degree of waste caused by dilution (excess air). Through unique means these conditions are measured directly on the two Heat Prover dials . . . one indicates the percentage of unused combustibles, and the other the percentage of excess oxygen which may be present in the spent gases. These readings are continuous and can be made at any instant from combustion samples taken from any part of the furnace, pit or crucible atmospheres.



NATIONAL BEARING METALS CORPORATION
[illegible] MANCHESTER AVENUE
ST. LOUIS 10, MO.

August 25, 1943

Mr. Albert F. Hake
Cities Service Oil Company
1320 Macklind Avenue
Saint Louis, Missouri

Dear Mr. Hake:

I wish to thank you and the Cities Service Oil Company for the use of the Heat Prover instrument.

The Heat Prover has been a great help in our maintaining the correct furnace atmosphere in all of our brass and bronze melting furnaces, both crucible and open flame types. This instrument gives a very fast and accurate reading on both oxygen and carbon-monoxide, as we have checked it a number of times with our standard Orsat equipment.

The biggest advantage, I feel, of your instrument is that I am able to get a continuous reading during adjustment of the furnace combustion and am also able to check and adjust sixteen furnaces in a few hours time that would be an all days job with Orsat equipment.

Sincerely yours,

Wm. M. Baxter III
Plant Metallurgist

Mail this Coupon

TODAY FOR AN INDUSTRIAL HEAT PROVER TEST OF YOUR EQUIPMENT—AT NO COST OR OBLIGATION TO YOU.

CITIES SERVICE OIL CO.
Room 146
Sixty Wall Tower
New York 5, New York

Gentlemen: Please contact me regarding your Industrial Heat Prover Test.

Name ____________________

Title ____________________

Company ____________________

City ____________________

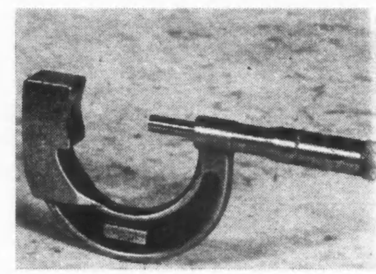
(Available only in Cities Service Marketing Territory East of the Rocky Mountains.)

CITIES SERVICE OILS
ONCE-ALWAYS

CITIES SERVICE OIL COMPANY
ARKANSAS FUEL OIL COMPANY

Micrometer Caliper for Setting Boring Tool

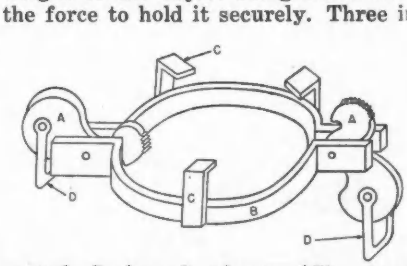
This micrometer is used at General Electric's Schenectady Works for gaging the setting of boring bar cutters, saves time and eliminates the guesswork involved in bringing the cutting tool to proper position by the usual cut and try method. It is a modification of a standard type with the anvil replaced by a block in which a recess is ground to accommodate the boring bar. A ¼-in. hole is drilled through the recessed portion of the block in line with the spindle to permit insertion of a wrench for easy adjustment of the tool in the boring bar.



To use the gage it is necessary to take one cut, and thereby determine just how much more stock has to be removed from the bored hole to bring it to proper size. The distance the tool protrudes from the bar can be determined readily with the gage. Then by backing off the spindle of the gage a distance equal to the amount of stock to come off each side of the bored hole, the tool point can be brought up to the gage spindle and locked in position.

Lifting Device for Cylindrical Parts

A lifting device for moving cylindrical objects to which it is impossible or impracticable to attach cables or eyebolts is saving crane operator and crane follower man-hours at the General Electric Company's Schenectady Works. As shown in the sketch, the device has two pivoting jaws (A) opposite each other on a ring (B). The jaws function in the manner of a pair of ice tongs in that they make the weight of the object being lifted exert the force to hold it securely. Three in-



verted L-shaped pieces (C) spaced around the outside diameter of the band, position the device when it is lowered over the object to be lifted. Then a crane is attached to the clevises (D) on the two jaws, and the subsequent lifting movement pivots the two jaws down and inward so that they hold the positioned object firmly.

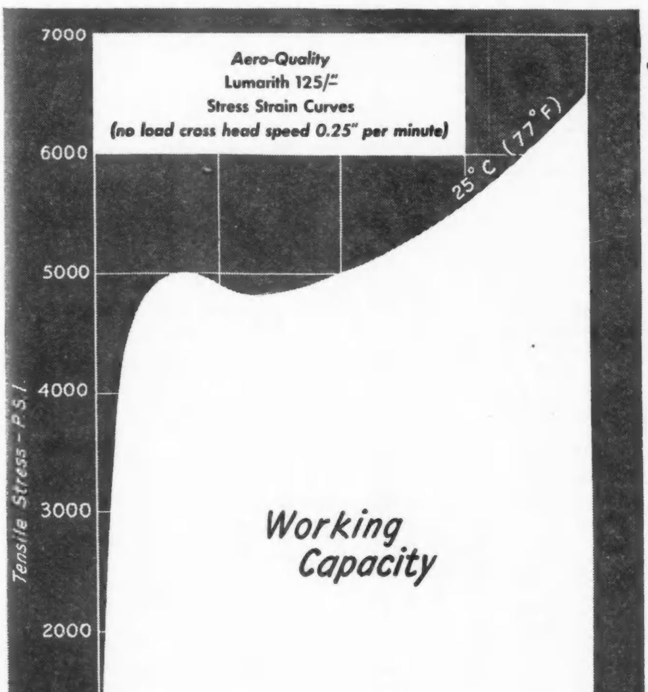
THE TOUGHNESS OF

Aero-Quality LUMARITH*

Gives Aircraft Designers a Chance to do things They Haven't Done Before

IMPACT STRENGTH

The impact strength of Lumarith is quite amazing. . . . Down around the minus sixties (Fahrenheit), it is about what designers are accustomed to expect from other plastics—that is 0.4 ft.-lbs. per inch of notch Charpy, on an ⅛" sheet at 50% R.H. But from there up, on the temperature range, the impact strength of Lumarith leaves other types of plastics for aircraft glazing far behind. . . . At 40° F., Lumarith impact strength passes 1.0 ft.-lbs. . . . At 150° F., it is greater than 4.0 ft.-lbs.



SELF-DISTRIBUTION OF LOCAL STRESSES

Another strong point in Lumarith's properties is its ability to relieve stress concentrations. With Lumarith, due to its "give," local stresses are readily transmitted to neighboring sections so that a more uniform stress distribution is obtained and local failure is less likely to occur.

WORKING CAPACITY

The areas under the Aero-Quality Lumarith stress-strain curve show its excellent resistance to breaking or cracking under deformation. The figures are: 42 ft.-lbs. per cubic inch at 32° F. . . . 170 ft.-lbs. per cubic inch at 77° F. . . . 195 ft.-lbs. per cubic inch at 95° F. Above 100° F., other accepted plastics match Lumarith in this phase of toughness. But at the usual operating temperatures, Lumarith rapidly steps into a class by itself.

If you haven't received a complete set of graphs on Aero-Quality Lumarith, send for them immediately to Celanese Celluloid Corporation, *The First Name in Plastics*, a division of Celanese Corporation of America, 180 Madison Avenue, New York City 16.

*Reg. U. S. Pat. Off.

Standardization of Aircraft Tubing

National Tube Co., United States Steel Corp. Subsidiary

IN THE construction of the airframes, engine mounts, landing gears, wing spars, and a great many other parts of America's armada of planes, alloy steel tubing is being used in tremendous quantities. The use of seamless tubing in aircraft construction is the natural outgrowth of another application of this versatile product where strength-weight ratio has been a dominant factor. Light gage steel tubing had its first major application in the bicycle frame, and for over a period of 50 years no better type of construction has been developed, for no other structural section will withstand the combined stresses of tension, compression, bending, and torsion, as well as the round tubular section.

These factors admirably filled the rigid requirements in the construction of vital parts of the modern plane and the unprecedented demand for aircraft has called for hundreds of millions of feet of seamless tubing, taxing the capacity of all existing tube plants and now being supplemented by new seamless tube mill capacity.

The airplane designer must hold the dead weight of the plane to the irreducible minimum, calculate the stresses of each member accurately and then select materials and part sizes that will safely withstand these stresses. Fortunately for all concerned, grades of material for steel tubing were, or have been standardized, and practically all structural tubing is being specified in plain carbon (SAE-1025) and chrome molybdenum (SAE X-4130), of which the latter is used in practically all but light trainer type planes. Due to the difficulty in securing ample supplies of X-4130 steel, chrome nickel molybdenum (NE-8630) steel is now being used as an alternate material in increasing quantities. Unfortunately, however, standardization of sizes of tubing due to design requirements has been very difficult and both consumers and suppliers must share the responsibility for this situation. The designer, who must get the last pound of strength and save the last ounce of weight in his structure, naturally wants a wide choice of sizes and gages of tubing to

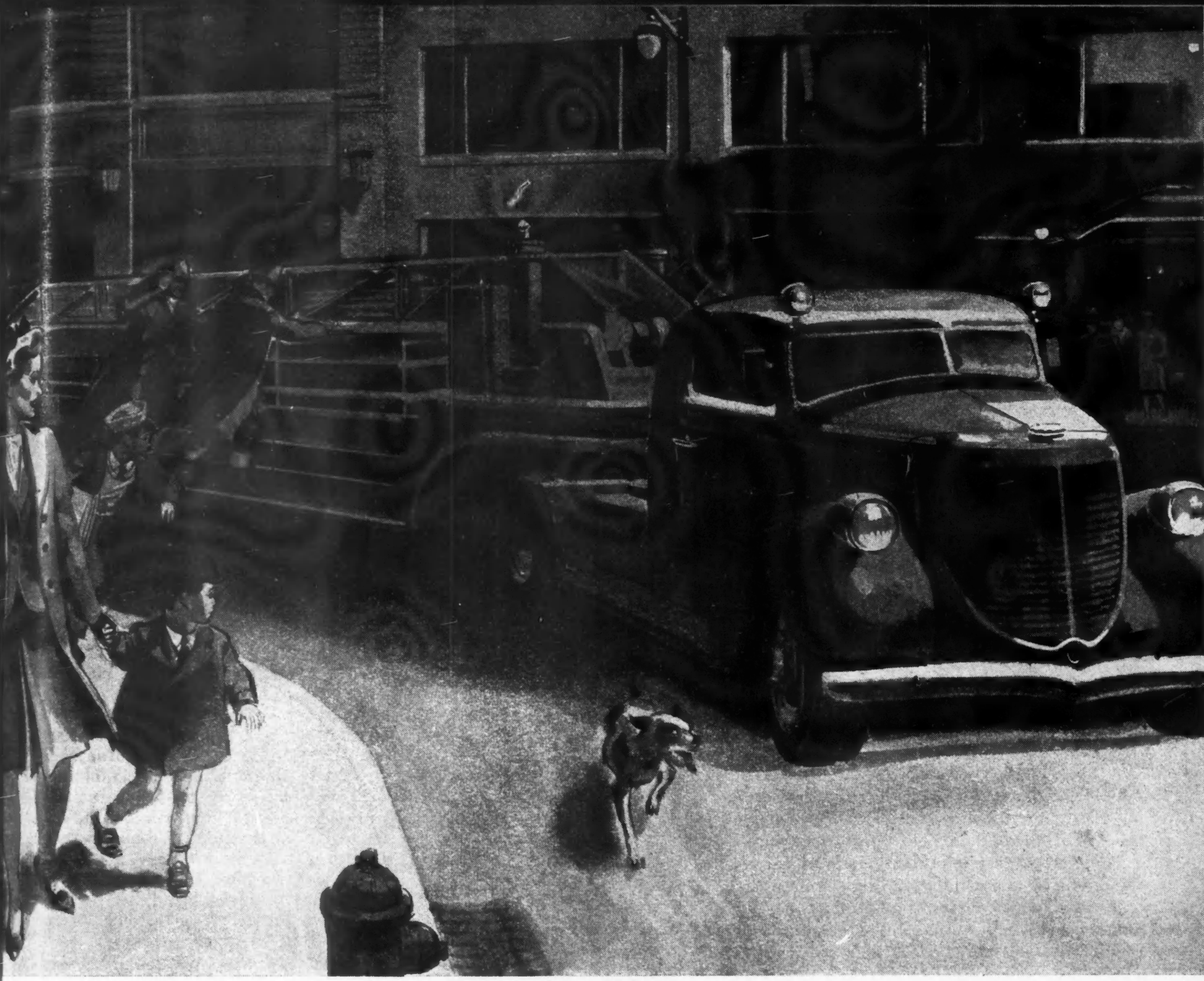
(*Turn to page 288, please*)

Proposed Standard Sizes of Aircraft Tubing

Wall Thickness (In.)	Outside Diameter (In.) 3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
.022	22	22	22	22	...	...	...	...
.028	28	28	28	28	28	28	...	28
.035	35	35	35	35	35	35	35	35
.049	49	49	49	49	49	49	49	49
.058	...	58	58	58	58	58	...	58
.065	...	65	65	65	65	65	65	65
.083	...	...	...	83	83	83	...	83
.095	...	...	95	95	95	95	95	95
.120	...	...	...	...	...	120	120	120
.156	...	...	...	...	...	...	...	156
.188	...	...	...	...	...	...	...	188

Wall Thickness (In.)	Outside Diameter (In.) 3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8
.028	28	28	28	28	...	...	...	...
.035	35	35	35	35	35	35	35	...
.049	49	49	49	49	49	49	49	49
.058	58	58	58	58	58	58	58	58
.065	65	65	65	65	65	65	65	65
.083	83	83	83	83	83	83	83	83
.095	95	95	95	95	95	95	95	95
.120	120	120	120	120	120	120	120	120
.156	156	156	156	156	156	156	156	156
.188	188	188	188	188	188	188	188	188
.250	250	...	250	250	250	...	250	...
.313	...	...	...	...	313	...	...	...
.375	...	...	...	...	375	375	...	...

Wall Thickness (In.)	Outside Diameter (In.) 1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3
.035	35	35	35	...	...	...	...
.049	49	49	49	...	...	...	...
.058	58	58	58	58	...	...	58
.065	65	65	65	65	65	65	65
.083	83	83	83	83	83	83	83
.095	95	95	95	95	95	95	95
.120	120	120	120	120	120	120	120
.156	156	156	156	156	156	156	156
.188	188	188	188	188	188	188	188
.250	250	250	250	250	250	250	250
.313	313	...	313	313	...	...	313
.375	...	...	...	...	375	375	...
.500	...	...	...	...	...	500	...



ALERT TO ANY EMERGENCY

Though their numbers are relatively small, their friends are legion . . . which is just another way of saying that the nation's foremost fire departments depend upon genuine Bendix-Westinghouse Air Brakes for that quick, positive stop and smooth, effortless, balanced braking over the entire speed range ★ Bendix-Westinghouse congratulates those authorities of city, state, and nation who have recognized the pertinent fact that the world's most effective safety campaign begins right in City Hall and whose safety records with Bendix-Westinghouse equipped units vindicate their excellent judgment ★ Certainly, nowhere could brake performance be placed to a more grueling test than in this colorful service which was among the very first to adopt Air Brakes . . . And no finer tribute to the success of genuine Bendix-Westinghouse Equipment than the fact that it has since been continually specified as standard by the country's leading cities and towns for fire and other emergency vehicles ★ We urge you to consult your local distributor or write us direct for information relative to the many exclusive advantages this Safety Standard of the World holds for you.

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY . . . ELYRIA, OHIO

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AIR BRAKES

AND PNEUMATIC CONTROL DEVICES

BENDIX-WESTINGHOUSE AIR BRAKES

ARMY NAVY

IT IS SIGNIFICANT THAT AMERICA'S FINEST MOTOR TRUCK FLEETS ARE EQUIPPED WITH BENDIX-WESTINGHOUSE AIR BRAKES

(*Continued from page* 286)

reach these goals, and no criticism of his requirements in the development period of airplane construction is implied here. He found tubing manufacturers were willing to furnish almost any size and gage that was specified, as they were sympathetic to his problems, and at that time the small quantities of tubing required did not involve serious production problems.

While aircraft tubing is a special grade of cold drawn mechanical tubing, made to more exacting specifications than regular mechanical tubing, yet, practically all producing equipment and tools used in the whole range covered in the regular mechanical tubing field were available for its manufacture. Producers of cold drawn mechanical tubing were, therefore, readily equipped to make all sizes and gages between 1/16 in. outside diameter, and 10¾ in. outside diameter, with walls from .004 in. thick to 1⅝ in. thick, and a weight table listing the sizes that were obtainable within these ranges included over 4300 items.

In the early development of airplanes only the smaller diameter and lighter wall tubing entered into the construction of the small planes then built, and only such items were shown on lists of sizes available in the aircraft grades. These early published lists included about 240 items items, ranging from 3/16 in. to 5 in. outside diameter by .022 in. to .375 in. wall thickness.

Army-Navy Aeronautical Design Standard, approved June, 1940, listed but 146 items, 3/16 in. to 4¾ in. outside diameter by .022 in. to .188 in. wall. In 1942 the steel tubing industry was asked to make about 600 round sizes of X-4130, and over 200 round sizes of 1025 grade tubing, a considerable increase.

However, a detailed study made in that year showed that four leading manufacturers of aircraft tubing received orders for 328 sizes of airframe tubing in the first ten months of 1942. Over thirty-three million feet of airframe tubing was involved, of which about 95 per cent was covered by a list of 205 sizes. This list is submitted herewith as a standard which might be adhered to without hardship for either design or production. It was compiled from orders received over a period of years and therefore represents the aircraft industries choice of sizes of tubing required to meet the major portion of all design requirements. While it is not possible for the aircraft manufacturer to adhere strictly to this list, and tube manufacturers are prepared to make additional sizes not listed, it is hoped that sincere effort will be made to conform to the list as nearly as possible. From the manufacturer's standpoint, the advantage would be two-fold, namely, increased production and reduced cost, both of which would be passed along to the consumer in the form of better deliveries and lower prices.

If orders for other than standard sizes were for substantial quantities the mill problems would not be so complicated, but unfortunately they are almost without exception for small quantities requiring more detailed attention than the large orders for standard sizes. When 95 per cent of all orders are for standard sizes, it is readily seen that many consumers' orders can be grouped, thus permitting long mill runs on individual sizes, and creating a liquid stock reservoir that can be tapped in emergencies. Further, and of equal or greater importance, standardization of sizes permits actual stocking of finished tubing in both mill stocks and distributors' warehouses when conditions of supply and demand permit.

Warehouse stocks would be more useful because the number of sizes in any one warehouse would be tremendously reduced, and if the whole industry standardized on fewer sizes the warehouse stocks become more interchangeable from one section of the country to another, instead of being localized to serve a few nearby consumers. Furthermore, inactive and dead stocks would be reduced to a minimum. The same conditions would obtain in consumers' stocks, with a reduction of inventory and stock control problems.

(*Turn to page* 290, *please*)

THE police show ups provide a quick and effective means of putting public enemies on the spot.

Just as quickly, the enemy of high-speed machinery —*vibration*—is recognized and prevented from preying upon assemblies with vital rotating parts.

With the keen perception of the electronic tube and the stroboscopic lamp, Dynetric Balancing Machines* *locate* and *measure* unbalanced forces so quickly and infallibly that accurate static and dynamic balance has become a matter of low cost routine for quality products.

**A development of Westinghouse Research Laboratories.*

GISHOLT MACHINE COMPANY
1205 E. Washington Ave. • Madison 3, Wis.

Look Ahead . . . Keep Ahead . . .
With Gisholt Improvements

GISHOLT

DYNETRIC BALANCING is serving vital war industries by assuring smoother performance and longer life in such parts as radial and in-line crankshafts, armatures for electric motors and generators, super-charger impellers, and dozens of other high-speed rotating parts. The Dynetrics can also help you make a better product in the postwar period. Write for literature.

TURRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES • SPECIAL MACHINES

Identification of various sizes in the fabrication lines would also be simplified, thereby minimizing costly mistakes by inexperienced workers. The purchasing departments, too, would have their work lightened and expedited through any reduction of items, particularly since all orders must clear through the Aircraft Scheduling Unit of War Production Board, Wright Field, Dayton, Ohio.

Jigs and fixtures, as well as fittings, would be reduced in proportion to number of items. Aside from simplification problems in manufacturing plants, greater advantages would be gained in widely scattered service and repair depots where parts must be available at all times to service many different types of planes.

This discussion does not include tubings used in landing gear, engine parts, propeller blades, pressure lines, etc., although standardization of sizes of tubing for such applications is equally important and desirable.

In adopting and recommending standardization of the sizes referred to in this article, the fact that actual requirements of special sizes will still be available should always be kept in mind, and where quantities are sufficiently large there is no objection on the part of the manufacturer to accept orders for such items.

No radical or revolutionary recommendations are being advanced. A reference to the records of the American Standards Association will reveal hundreds of industries that have put standdardization of their products into effect and always to the mutual benefit of the producer and consumer.

In conclusion, it should be stated that the airframe manufacturers have wholeheartedly endorsed the above recommendations and through this recognized standardization body, the National Aircraft Standards Committee, are continuing to explore the possibility of further standardization of sizes with the objective in mind of reducing the number of sizes to a minimum consistent with sound aircraft engineering practices.

Moore to Distribute Tocco Equipment

Appointment of The Moore Machinery Company, Los Angeles and San Francisco, as special distributors for Tocco Process induction heating and hardening equipment has been announced by The Ohio Crankshaft Company, Cleveland, Ohio. The Moore Machinery Company will handle distribution in the California, Nevada and Arizona territories. This appointment brings to nine the number of distributors handling the Tocco line.

INVADERS!

Hudson Engines, Equipped with Federal-Mogul Bearings, Power Landing Craft

Precision-built Hudson *Invader* engines, produced by the Hudson Motor Car Company, equipped with Federal-Mogul sleeve bearings, power swarms of personnel landing craft that carry our own and Allied fighting men to beach-heads and invasion.

Like many other power units built to the highest standards of performance, Hudson *Invaders* use Federal-Mogul Steel and Bronze Back Babbitt-lined bearings. Twenty-four hours a day our six well-equipped plants turn out tens of thousands of sleeve bearings, bushings and precision parts to equip planes, landing gear, ships, tanks, torpedoes, trucks, submarines—while Federal-Mogul propellers provide dependable propulsion on these same personnel landing craft, as well as the famous PT boats and many others.

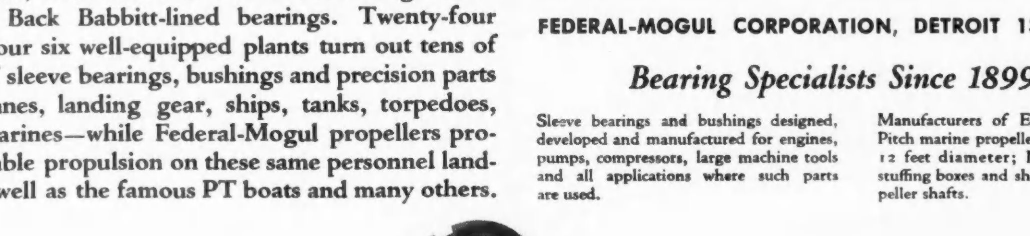
When the war is over, Federal-Mogul sleeve bearings will revert to constructive, peacetime service on automobiles, refrigerators, trucks, tractors, diesel engines, steam turbines, electric motors, marine engines. Remember that wherever shafts turn in sleeve bearings, for 45 years FEDERAL-MOGUL sleeve bearings have been the recognized standard of dependable quality.

FEDERAL-MOGUL CORPORATION, DETROIT 13, MICHIGAN

Bearing Specialists Since 1899...

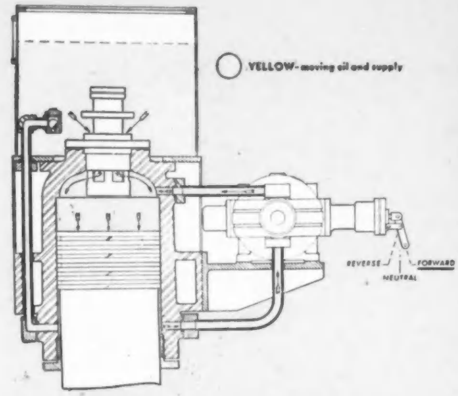
Sleeve bearings and bushings designed, developed and manufactured for engines, pumps, compressors, large machine tools and all applications where such parts are used.

Manufacturers of Equi-Poise and Tru-Pitch marine propellers from 8 inches to 12 feet diameter; Equi-Flex cushion stuffing boxes and shaft logs; struts, propeller shafts.

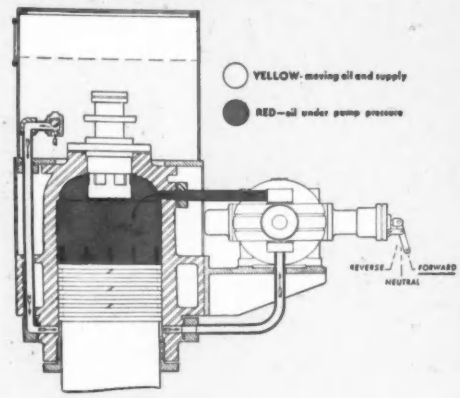


FEDERAL-MOGUL

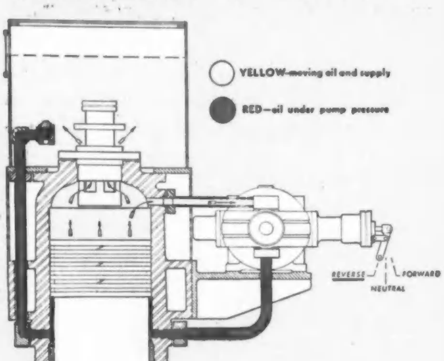
SLEEVE FEDERAL Mogul **BEARINGS**



FAST RAM ADVANCE—The H-P-M radial pump withdraws oil from the differential ram supporting area. The press ram rapidly advances to the work. Its speed is definitely governed by the rate the oil is withdrawn from the differential ram area. During rapid ram advance, the press cylinder is prefilled by gravity from the overhead oil supply tank.



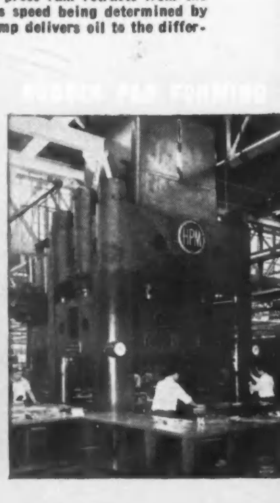
RAM ADVANCE UNDER PRESSURE — The advancing ram encounters the resistance of the work. At this point, the ram continues its forward travel but at reduced speed, being propelled solely by the oil delivered by the radial pump. As soon as a predetermined pressure is built up on the work, the delivery of the radial pump is automatically reversed.

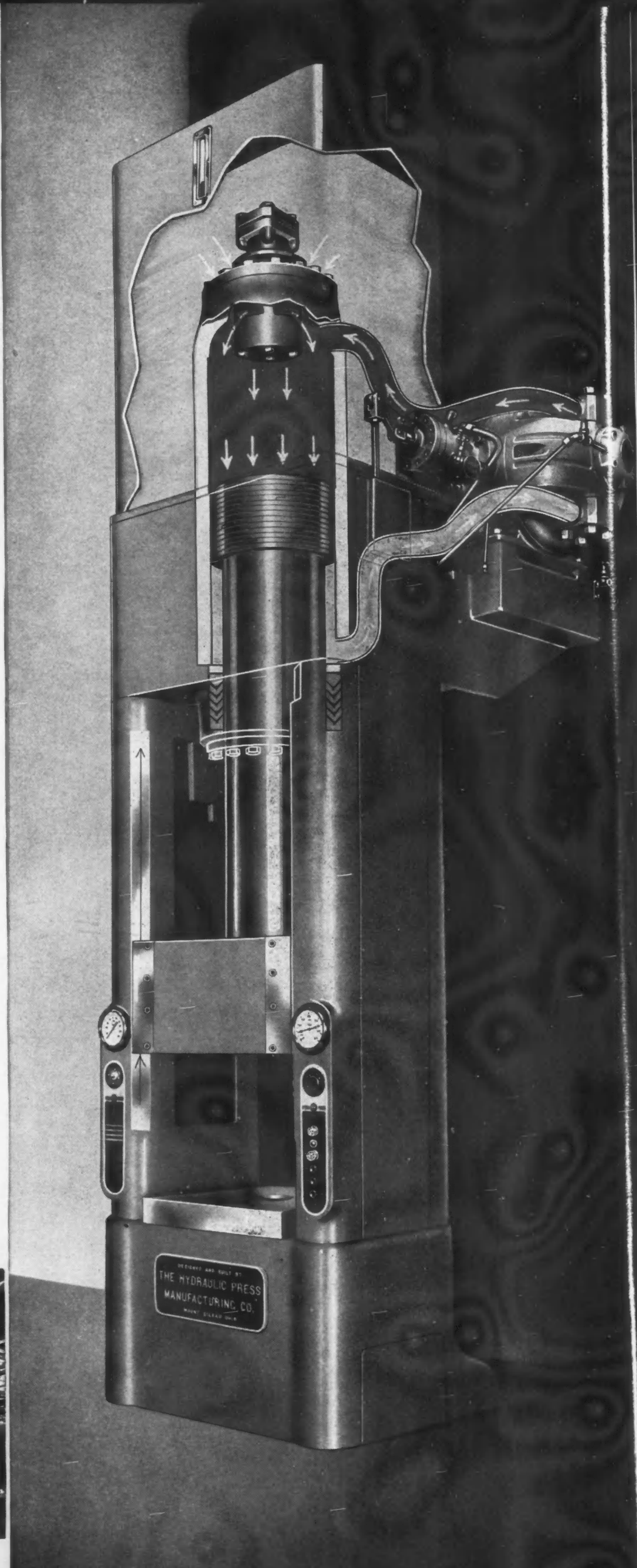


FAST RAM RETURN—The pump now delivers oil to the differential ram supporting area. The H-P-M FASTRAVERSE valve opens automatically, reestablishing communication between cylinder cavity and overhead tank. The press ram retracts from the work at a rapid rate, its speed being determined by the rate at which the pump delivers oil to the differential ram area.

DEEP METAL DRAWING

RUBBER PAD FORMING





Thousands of man-hours SAVED...

ON THE WAY TO THE ASSEMBLY LINE
Completely finished by Reynolds' skilled workmen these prefabricated plane parts will save manpower, plant space, transportation and scrap handling for some busy plane manufacturer. Why not you?

by Prefabricated Plane Parts Service ... Pioneered by REYNOLDS

Here's one answer to your manpower shortage. An answer that's already saving thousands of precious man-hours of airplane labor for every leading manufacturer of combat planes.

Under this plan, pioneered by Reynolds only 3 years ago, completely finished parts come to your production lines ready for immediate assembly. No longer is it necessary to tie up valuable plant space with large stocks of aluminum sheet or die-cutting and forming machines.

Big savings in scrap handling realized

The Reynolds prefabricated plane parts service also does away with scrap handling. Aluminum scrap, which averages 30% of every sheet, is immediately re-rolled into prime sheet, then prefabricated into more new parts, practically overnight.

It is this kind of progressive thinking and co-operative planning that has resulted in an organization which now operates 40 plants in 14 states, and continues to grow by leaps and bounds. For Reynolds men are not satisfied to have been the first to supply finished plane parts from aluminum sheet. They have given themselves the continuous job of finding new ways to make aluminum better . . . easier and cheaper to use.

That's why you'll find Reynolds' resources, equipment and engineering skill can be of assistance in helping you with your aluminum problems, *no matter what they may be.* Reynolds Metals Company, Aluminum and Parts Divisions, Louisville, Ky.

REYNOLDS METAL

REYNOLDS *The Great New Source of* **ALUMINUM**

INGOT · SHEET · EXTRUSIONS · WIRE · ROD · BAR · FORGINGS · TUBING · FOIL · POWDER

New Production Equipment

(*Continued from page* 144)

gaged with the slowly rotating grinding wheel and through what may be termed pressure milling action, the form of the crusher roll is reproduced on the wheel. With the wheel crushing method of dressing, all of the ribs on the multi-ribbed grinding wheel can be dressed simultaneously in less time than is taken to dress a single point wheel.

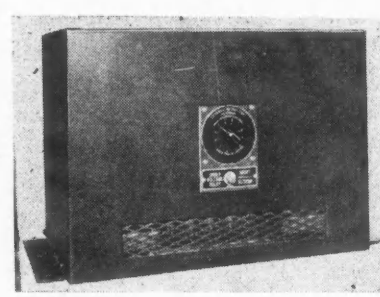
In plunge thread grinding, the length of the thread is limited to the width of the wheel which is brought into full depth with approximately 1/3 of the revolution of the work head. A fully threaded part, for example, is completed in another full revolution, or a total of one and one-third revolutions for the entire operation. When plunge grinding forms, the wheel is pushed into full depth in one or more revolutions of the work head, depending upon the depth of the form.

Compared with single point grinding, production of most parts can be stepped up approximately two to four times. Commercial threads of class three fit are said to be easily obtained. Where the length of the threaded part exceeds the maximum allowable wheel width, it is possible to traverse grind up to a maximum of 8 inches length of thread.

A THYRATRON welding control for providing precise control of low-capacity spot welders has been brought out by the General Electric Company, Schenectady, N. Y. Coupled with a suitable welding transformer, this control can be used with either welding tongs or a small bench welder.

Suitable for operation on either 230 or 460-volt, 60-cycle power supply, the new control is an adjustable, synchronous-precision, electronic type in which only three thyratron tubes perform all the functions. Two Type FG-172 tubes control the primary current of the welding transformer, and a single Type FG-97 tube controls the firing time. Since the tubes have the same current rating on either voltage, the transformer used on a 460-volt supply can be twice as large as that used on a 230-volt source, which will approximately double the secondary current. The control is rated 53 amperes rms (primary current of the welding transformer) on a duty cycle not exceeding ten per cent.

The new control is mounted on a compact, dead-front



G-E thyratron welding control

metal enclosure designed to permit the control to be attached either to the top of the assembly bench or underneath, by a simple reassembly of parts. A calibrated time adjustment on the front of the panel provides either one-half cycle or any number of complete cycles from one to ten.

THE Cosa Corporation, New York, N. Y., is the exclusive representative in the United States and Canada for the RU-2 high precision thread grinder manufactured by Societe Genevoise, Geneva, Switzerland. This machine, which grinds internal and external threads, is equipped with a microscope with a revolving reticle for inspecting both wheel and work profiles. The microscope is easily tilted out of the way during the grinding operation.

The RU-2 has a temperature compensator which permits at will the increasing and decreasing the pitch of the threads ground, either to allow for the cooling effect of the

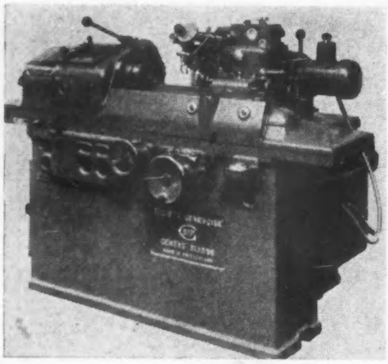
Hauling America's Most Critical Jobs . . .

Spicer Transmissions, Auxiliaries and Universal Joints

Hauling massive logs from mountainside forests, and moving great hull sections in busy shipyards . . . these are a few of the jobs which Spicer-equipped trucks are doing to meet America's urgent wartime material and construction needs. Wherever men, materials and munitions must be moved . . . on the battle front and home front . . . Spicer Transmissions, Auxiliaries, Universal Joints and Axles deliver power that will help us reach the goal of peace. Then Spicer again will be ready to serve immediately the tremendous needs of America's automotive industry. Spicer Manufacturing Corporation, Toledo, Ohio.

41 YEARS OF Spicer SERVICE

BROWN-LIPE CLUTCHES AND TRANSMISSIONS • SALISBURY FRONT AND REAR AXLES SPICER UNIVERSAL JOINTS • PARISH FRAMES, STAMPINGS



RU-2 high precision thread grinder

water supply or to obtain a pitch value which will be correct at a certain temperature other than the standard temperature of the machine.

METAL tags for every identification purpose are quickly embossed with the new "Quick-Set" embossing machine offered by Jas. H. Matthews & Co., Pittsburgh, Pa. The machine is designed to meet the need for frequent changes in set-up and will accommodate either coiled sheet metal strips, which are cut into tags of any desired size, or tags already cut to size.

Manufactured to order, the machine can be supplied to emboss as many as 16 characters at one time, from 3/16 in. to ½ in. in size, with each embossing bar limited to maximum of 13 characters. Maximum tag thickness recommended for use with the machine is 24 gage, but under certain conditions, heavier materials may be satisfactorily embossed. The machine will emboss one line of characters only.

The projecting levers on the top of the machine are used to move steel bars forward or backward into position for the embossing operation, as indicated in a view window provided on top of the machine. The material is placed into a side slot, and the complete set-up is quickly embossed by a kick of the foot treadle.

Matthews "Quick-Set" embossing Machine

The "Quick-Set" embossing machine can be furnished in the floor model as shown or in a bench model.

THE Doall Mobile Inspection Unit, a product of Continental Machines, Inc., Minneapolis, Minn., contains the necessary instruments and gages ordinarily found in an inspection department. From light waves viewed through an optical flat, produced by a monochromatic light as its basic standards of measurement, there is provided a set of Doall gage blocks, gaging instruments and comparator to interpret this unwavering standard of measurement in checking dimensions of parts and tools. The set of eighty-three precision gage blocks have an accuracy in height, flatness and parrallelism which is plus or minus .000004 in. A calibration chart lists height, flatness and parallelism of these gage blocks. The set of twenty different precision measuring instru-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YOU CAN FINISH ALL THESE GEAR TYPES ON MICHIGAN MACHINES
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ments include calipers, trammel points, center points, scribers, base blocks, gage holders of 2 in., 6 in., 9 in. and 12 in. capacities, vernier gage block, master square, sine bar, straight edges, master flat and a 12 in. by 24 in. precision surface plate. The new Doall comparator gage has four ranges of magnification with 6½ in. height gaging capacity and 4 in. throat capacity including variable spindle pressure of from eight ounces to forty ounces. An illuminated magnifying glass on a stand is also provided.

Doall Mobile Inspection Unit

The accuracy of these instruments against wear, dirt and rough handling is in turn quickly checked by using the optical flats and monochromatic light.

RADIAC synthetic rubber cut-off discs and grinding wheels which have been added to the line of A. P. de Sanno & Son, Inc., Phoenixville, Pa., are said to be superior in many respects to crude rubber discs and wheels. The new synthetic rubber wheels and discs are manufactured in the standard range of thicknesses and diameters up to 20 in.

The manufacturer states that Radiac synthetic rubber wheels have shown effective performance on wet grinding of ball bearing races and roller bearings. Synthetic cut-off discs show fast cutting qualities on cold rolled and high speed steels, roller bearing stock, glass rods and tubing.

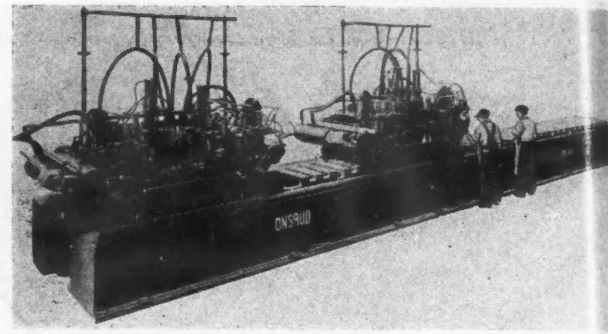
THE Onsrud Machine Works, Inc., Chicago, Ill., has redesigned the original A80-A Onsrud automatic contour miller. Features of the original machine which have been retained in the new A80-A are: the use of the high rpm cutters and fast feed; pattern control of cutter travel; automatic cam bar feed control; method of bringing cutter heads to the work by means of a movable carriage and pneumatic hold-down pressure.

The A80-A employs eight cutter heads, mounted on two carriages, to automatically mill long, nonferrous air-

craft parts, such as spar channel beams and cap strips. Each carriage mounts two vertical and two horizontal cutters, and all eight cutters may be used at one time if the nature of the work requires. This involves a two-station set-up, the work being moved from one station to the next as the cutters on each carriage finish their respective operations. Carriages ride on the bed of the machine and work is held to the table by air operated clamps. Carriage speed ranges from 4 in. to 18 ft. 6 in. per minute.

Cutter motor speeds on the A80-A go as high as 10,800 rpm providing lineal cutter velocities of from 5,000 to 8,000 fpm. The eight cutter motors are rated at 180 hp normal. These motors are capable of 100% overload because of a special water cooling system, thus making available a total of 360 hp. A G-E Thy-Mo-Trol system is used on the A80-A to convert ac to dc and so provide the stepless wide range drive of a dc motor.

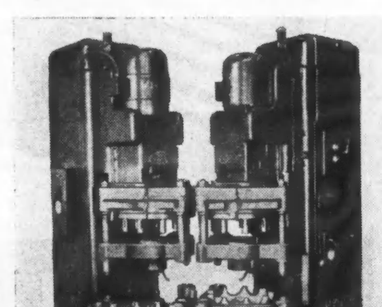
Overall length of this new Onsrud spar miller is 60 ft and the bed may be made still longer, if the nature of the work requires, by adding sections which can be supplied in 7½-ft or 15-ft. sections.



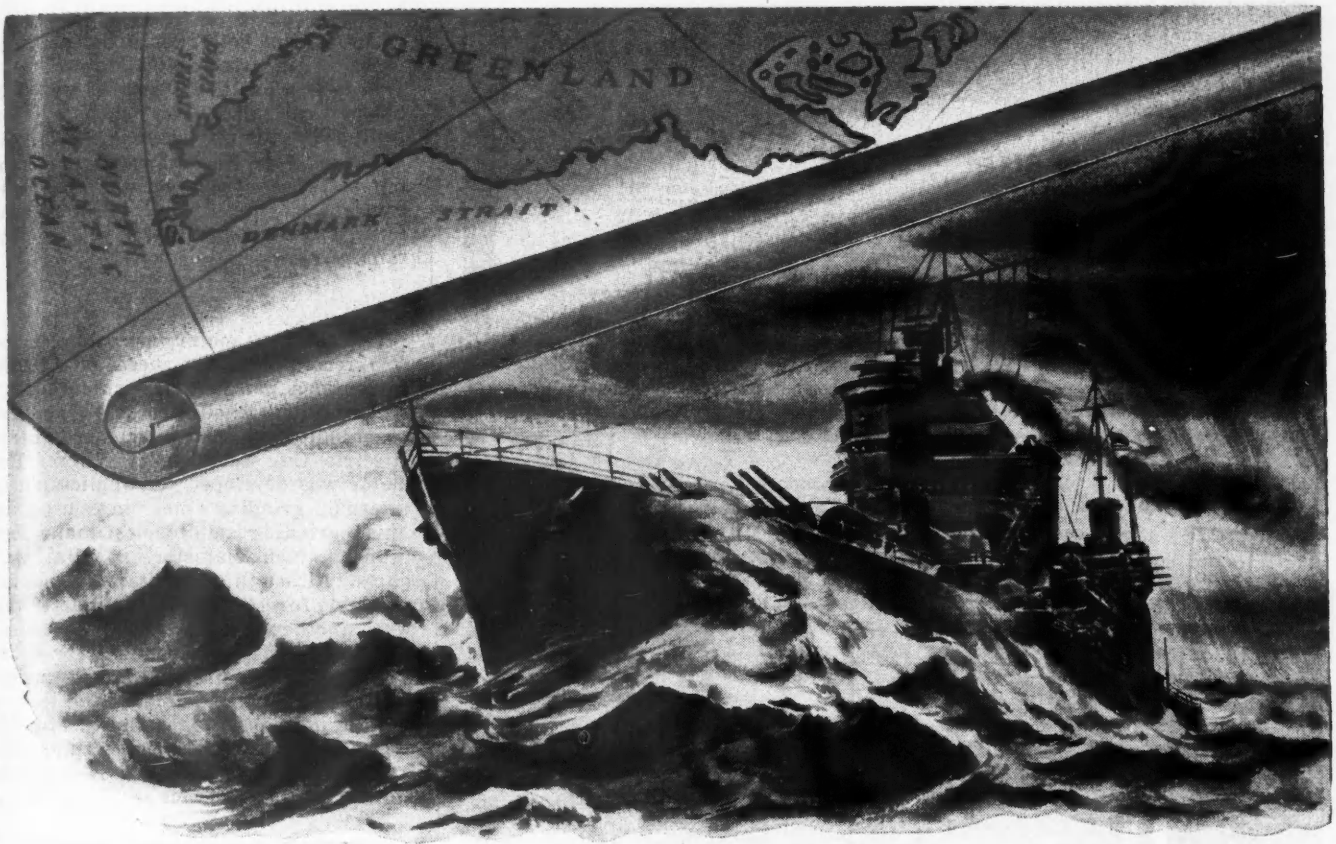
Onsrud automatic contour miller

SNYDER TOOL AND ENGINEERING COMPANY, Detroit, Mich., is building a special machine for reaming leg holes in aircraft crankcase sections. Two Snyder 10 V 18 standard drilling machine column assemblies are mounted upon a special base. Four fixtures are mounted upon a 60-in. diameter turntable which is mechanically indexed through a Geneva mechanism.

Work-cycle is semi-automatic. When starter button is pressed, the table indexes and reamer heads automatically advance the tools through the work. Table indexes again and at the next station the first nine holes are completed. The third index brings the part to the right-hand loading station. Part is reversed, reloaded in the left-hand loading station and again indexed



Special Snyder machine for reaming leg holes in aircraft crankcase sections



SOMEWHERE EAST OF GREENLAND

She's on her own out here, a thousand miles from a friendly port . . . twice that from a repair base. That's one reason she carries Diesel engines as well as her turbines — to provide auxiliary power in emergencies, for the operation of lights, ammunition hoists, and the like. Many smaller craft use Diesel as prime power too . . . for Diesel offers many advantages at sea — fuel economy, efficient use of bunker capacity, low fire hazard. The same advantages and others dictate the use of Diesel in countless military and commercial applications. Served by many progressive engine builders, America will enjoy rich future benefits as Diesels take over the manifold tasks for which they are ideally suited. As a supplier of fuel injection equipment to American engine builders, American Bosch continues to provide competent world-wide maintenance service, the widest variety of equipment, and experienced counsel in application engineering.

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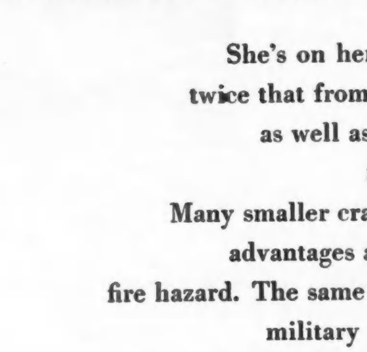


AMERICAN BOSCH

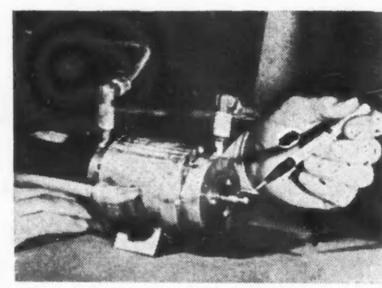
AVIATION AND AUTOMOTIVE ELECTRICAL PRODUCTS • FUEL INJECTION EQUIPMENT

through both work stations, completing reaming from both ends of holes. Three parts are in process at all times.

Spindles on the 9-spindle multiple heads are ball-bearing mounted and equipped with oil fingers. Coolant is brought to the tools through the bushing plate. A special welded steel base contains the index mechanism for the table, electric drive motor and coolant tank.

AN ELECTRIC motor operating at the record-breaking speed of 120,000 revolutions per minute, or more than seven million revolutions per hour, has been built and tested by the General Electric Co., Schnectady, N. Y. The motor was developed for application to internal grinding machines used in finish grinding small holes, many less than ¼ inch diameter, in vital war parts. Although the motor will not be available for general use until after the war, another possibility for its use is in driving small drill chucks for drilling tiny holes in soft metals using drills 1/32 inch in diameter and less.

With normal voltage applied at 2000 cycles, the new motor reaches full speed in less than a second. It is rated 3 horsepower and weighs but seven



G-E 120,000 rpm motor

pounds. The motor is so small that it fits into the palm of a person's hand, while its rotor is scarcely larger than a man's thumb.

Tests the motor has passed successfully at 120,000 rpm include eight-hour continuous runs at rated horsepower as well as grinding tests with a tiny grinding wheel mounted directly on the motor shaft.

Special oil-mist lubricated type ultra-precision bearings are used. The amount of material used in the motor is so small, with a consequent reduction in radiating surface, that water cooling is utilized, one-half a gallon a minute being used.

A RECENT addition to the De-Sta-Co line of the Detroit Stamping Company, Detroit, Mich., is a small, light duty toggle clamp with a T-shaped handle, which is said to increase efficiency of operation in spots where limitation of overhead space prohibits the use of the larger or taller clamps. In those places the T-handle provides a firm grip which would be impossible to

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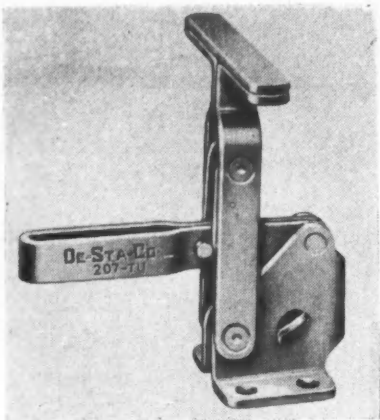


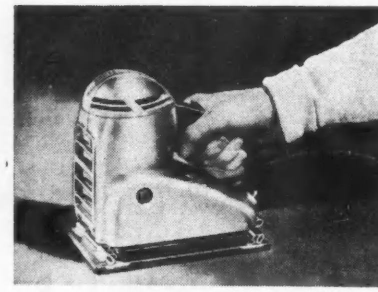
De-Sta-Co toggle clamp

secure with a shortened straight handle of the standard type.

The new clamp is available with either the straight solid work bar, De-Sta-Co Model No. 207-TS, or the U bar, Model 207-TU. In this latter model the retaining bolt can be set at any desired distance from the handle, thereby making the clamp adaptable to varied job requirements.

Dimensions are 3⅞ in. from end of work bar to end of base and 4 in. high overall when locked in position as illustrated.

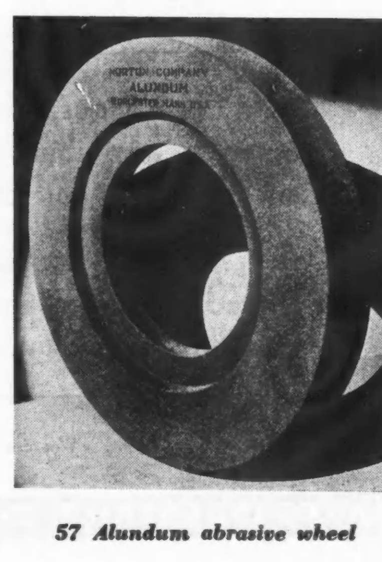
A FEATURE of the new Sterling 1000 electric portable sander, made by the Sterling Tool Products Company, Chicago, Ill., is the flexible sanding pad which detaches from the machine by pulling out a latch. Several pads loaded with abrasives can be kept near work for quick exchange. When different grades of abrasives are used on a job, additional pads loaded with coarse and fine grits can be switched when necessary, thus avoiding the necessity for operator to stop work and reload.



Sterling 1000 electric portable sander

The Sterling Sander is designed to cover the entire range of abrading coarse sanding to lapping and finishing. The sanding pad is flexible and will conform to convex or concave surfaces of moderate curvature. Special pads for unusual contour sanding or rubbing are also available. The tumbler action locks on the Sterling sanding pad can be operated by a key that is furnished with the machine or by a screwdriver. As tumblers are turned to lockup position, they draw in slack, pulling abrasive taut on pad. Tumblers operate with only about ¼ turn and lock abrasive securely in position.

NORTON COMPANY, Worcester, Mass., announces that grinding wheels made of their 57 Alundum abrasive are now available for general use. Fifty-seven Alundum abrasive is an improved aluminum oxide product which was de-



57 Alundum abrasive wheel

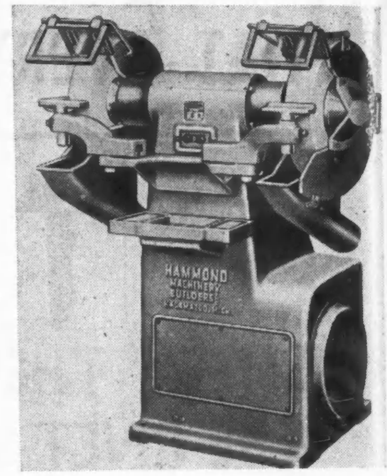
veloped by the Norton research laboratories several years ago.

Production facilities at the time of introduction were limited, however, so that it was necessary to confine the use of 57 Alundum grinding wheels to those critical war jobs where their special characteristics were most beneficial. Production capacity has now been increased so that 57 Alundum grinding wheels are available for all uses.

Fifty-seven Alundum abrasive is more friable than regular Alundum abrasive. This means that wheels of 57 Alundum have a fast, cool cutting action as they tend to keep themselves sharp but they also have the ability to hold shape and require few dressings.

NEWLY equipped grinders for magnesium grinding are now in production at Hammond Machinery Builders, Inc., Kalamazoo, Mich. Hammond 10 in., 12 in. and 14 in. grinders (Series RW) are equipped with heavy plate wheel guards which have direct exhaust outlets for connection to dust collecting system. The machines are equipped with explosion proof electrical equipment.

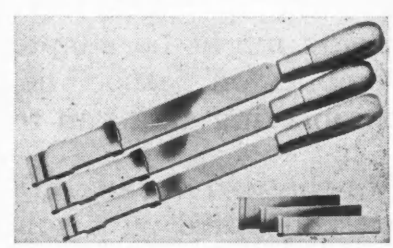
The "RW" series grinders, it is said, are equipped with large oversize spindles for smooth vibrationless operation, large bearings sealed against ingress of dust and grit, and multi V-belt drive so any desired spindle speed may be obtained. It is also claimed that the functionally engineered design of the base pedestal permits the use of any standard make of motor which offers an advantage when companies have standardized on their motor equipment.



Hammond magnesium grinder

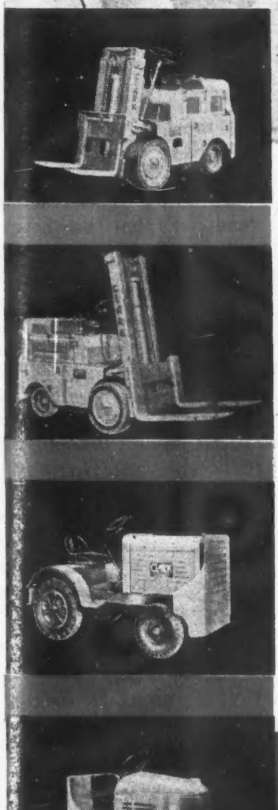
THE Doall Company, Des Plaines, Ill., has placed on the market a new type band saw for the cutting of non-metallic materials. It is called the Doall buttress saw, and, unlike conventional wood-cutting saws, the teeth are permanently hardened and are not to be resharpened or reset. The true alignment of set is said to result in a cutting tool minutely balanced for long life and uninterrupted production.

Carboloy Tipped Scraper Blades



Anderson Bros. Mfg. Co., Rockford, Ill., is making Carboloy tipped scraper blades in three widths to fit the Anderson standard line of hand scrapers. These new blades are interchangeable with the regular high speed blades furnished with the scrapers.

Keep this issue of AUTOMOTIVE *and* AVIATION INDUSTRIES. It is designed for a year of usefulness.



Air and Surface Transport Costs

(*Continued from page* 278)

listed, which account for over 90 per cent of the total cost of operation of each vehicle, only taxes and general office payroll fail to show at least twice as high a figure per mile for the airplane as for the bus of like payload capacity. A ratio of from two to three is the prevailing rule; but station expense for the airline, with its many items for specially-trained personnel who have no counterpart in bus operation, is more than five times that for the bus, and the ratio for traffic promotion and advertising is nearly nine to one.

The bus has but little advantage in weight. With equal payload capacity, the bus and the airplane are also very nearly equal in gross weight, the ratio of payload to gross typically being about 25 per cent in the former case and 20 in the latter.

To trace the explanation in a few outstanding cases, the airplane travels at four to five times the average speed of the bus; but it uses about twenty times as much power, with the result that the bus gives five miles per gallon as against only 1.6 for the airplane. The crew of a DC-3 normally cover about 150,000 miles a year as against about 60,000 for a bus driver; but the airplane carries a crew of three instead of one, and the total annual payroll for a full crew is about seven times the pay of a driver. The first cost of the airplane is approximately ten times that of the bus; and while it travels about six times as many miles in a year, and about four times as many in its total service life, the difference in first cost overrides the excess of mileage and gives the airplane a higher depreciation.

The ratios applying to most of these cost items will remain large, as far as we can now foresee. Since station payroll does not have to increase in direct proportion to amount of operation, increase of volume may bring the costs under that heading to only two or three times the bus figure, instead of 5½ times as at present. The startlingly high ratio of traffic and advertising costs may be reduced as the habit of travel by air becomes more widely established, and patrons need less constant and vigorous persuasion.

Supposing that a rate of 15 cents per ton-mile from airport to airport is the best that can be reasonably expected within the next few years, how much cargo traffic would it produce? Allowing for cost of pick-up and delivery, the imagined rate would be approximately a third of the present figure. No doubt the effect would be to multiply the prewar volume of air express at least by ten or fifteen—perhaps even more.

Although cost is certainly the most important factor in determining the future of cargo traffic, it is not the only one. The gentleness of air transportation will permit lighter and more economical packing. The costs and hazards of trans-shipment can often be escaped. The rapidity with which stocks can be renewed from the factory will enable distributors to cut their inventory of parts and retailers to reduce their stocks of finished articles, especially in foreign territory. The enormous growth in the use of air express during the war is a symbol of the generally increased pressure on industry in war; but it is a symbol also of the number of occasions on which business men previously but little acquainted with air transportation are learning new ways of employing it to advantage.

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RIES

Some Physical and Wear Characteristics

By Tracy C. Jarrett,* Chief Metallurgist, Koppers Co., American Hammered Piston Ring Division.

IN view of the success of porous chromium plated rings and the importance of their application, it was decided to study the effect of temperature on the hardness of the plate. It was thought that the chromium plate, due to its extreme hardness, would show good wearing qualities in the first hours of engine operation, but decrease rapidly as the time of engine operation increased.

Standard plain gray iron piston rings, porous chromium plated to a thickness of 0.005 in., were used for test purposes. The test specimens were heat treated at various temperatures ranging from 100 F to 1200 F. The specimens were held at these temperatures for a period of one hour, as previous experiments indicated that the greater part of the hardness change occurred within this time. The porosity was removed from the face of the ring (cylinder contacting surface) leaving the hard chromium highly polished for hardness measurements. The Tukon tester with a 100 gram load was used to determine the Knoop hardness numbers shown in the tables below.

The decrease in hardness is gradual up to a temperature of 500 F, with a sudden drop taking place between 500 and 600 F. The hardness then appears to remain at this new level up to a

Table 1

Wear of Chromium-Molybdenum Cylinders Run with Porous Chromium Plated Rings in 2000-Hp Engines Operated Under Abnormal Dust Conditions.

Eng. No.	Number Hours Operating Time	Cylinder Wear Measured on Diameter (in.)
A	34	0.002
B	94	0.002
C	106	0.002
D	192	0.002
E	245	0.004
F	310	0.003
G	315	0.003
H	460	0.002
I	539	0.001
J	590	0.003

Table 2

Wear of Chromium-Molybdenum Cylinders Run with Plain Cast Iron Rings in 2000-Hp Engines Operated Under Abnormal Dust Conditions.

Eng. No.	Number Hours Operating Time	Cylinder Wear Measured on Diameter (in.)
A	16	0.005
B	70	0.006
C	107	0.012
D	110	0.006
E	210	0.005
F	224	0.010
G	268	0.008
H	301	0.016
I	307	0.007

Table 3

Wear of Porous Chromium Plated Rings Operating Against Chromium-Molybdenum Barrels in 2000-Hp Engines.

Eng. No.	Number Hours Operating Time	Avg. Ring Wear[a] on Radius (in.)
A	36	0.000
B	68	0.001
C	108	0.002
D	168	0.0016
E	192	0.0029
F	315	0.0022
G	425	0.0032
H	453	0.0032

([a]) Average 0.005 in. chromium thickness on the radius originally.

* This article is an abstract of the paper presented at the War Engineering Annual Meeting of the Society of Automotive Engineers on Jan. 13 in Detroit.

of Porous Chromium Plated Piston Rings

temperature of 700 F, followed by a second sudden drop in hardness, ending at 900 F. The drop from 900 F to 1200 F is gradual, ending with a total hardness change of 400 Knoop hardness numbers.

The sudden drops in hardness were rather unexpected and a time-hardness curve was run on plated specimens at a constant temperature of 700 F to see if further changes would take place when held at this temperature for a long period of time. It was found that 90 per cent of the drop in hardness occurred within the first hour, and no further changes took place after 5 hours at this temperature.

Knowing that high temperatures would soften the chromium plate, it was decided to investigate the effect of engine operation on chromium plated rings in the field in regard to the softening and wearing characteristics. Aircraft engines, the largest users of chromium plated rings, were chosen as the ones to investigate.

Field Test Results — In an aircraft engine, it should be pointed out that only the top ring of each piston is chromium plated and the remaining compression and oil rings are plain gray iron. Field test data were obtained from different sections of the country and from different types of engines. The accompanying tables show the barrel wear of different types of engines, some using plain cast iron rings in the top groove, others with porous chromium plated rings in the top grooves:

From the data presented, it is obvious that cylinder wear is greatly reduced by the use of one porous chromium plated ring in the top groove. The porous chromium plated ring shows little wear under abnormal dust conditions; in fact the apparent life of porous chromium plated rings is exceptionally good. In view of the fact that the chromium plated ring possessed a hardness of approximately 850 to 950 Knoop hardness numbers originally, tests indicate that the chromium plate did not soften to any great degree. This would also show that apparently no unusually high temperatures had been reached in these engines.

Table 4

Wear of Nitrided Cylinders Run with Porous Chromium Plated Rings in 1200-Hp Engines.

Eng. No.	Number Hours Operating Time	Cylinder Wear Diameter (in.)
A[a]	28	0.001
B	593	0.000

([a]) Operated under abnormal dust conditions.

Table 5

Wear of Nitrided Cylinders Run with Plain Cast Iron Rings in 1200-Hp Engines Operated Under Abnormal Dust Conditions.

Eng. No.	Number Hours Operating Time	Cylinder Wear Diameter (in.)
A	32	0.009
B	81	0.006
C	195	0.008
D	265	0.008
E	407	0.009
F	559	0.010

Table 6

Wear of Porous Chromium Plated Rings Operating Against Nitrided Barrels in 1200-Hp Engines.

Eng. No.	Number Hours Operating Time	Avg. Ring Wear[a] on Radius (in.)
A	150	0.0011
B	593	0.0015
C	745	0.001

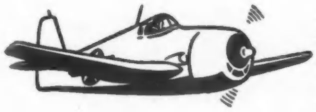
([a]) Average 0.005 in. chromium thickness on the radius originally.

The Navy's Pet Hellcats

use PORUS ★ KROME*

Hellcat fighters massed on the deck of an aircraft carrier. PORUS-KROME piston rings are used in their engines.

Official U. S. Navy Photograph



Navy pilots "give ribbons" to their Hellcats . . . blue ribbons for greater range, faster climb, higher ceilings and "sweet handling".

Hellcat engines actually do wear ribbons . . . PORUS-KROME "ribbons" on the compression rings. PORUS-KROME, .005″ thick, is molecularly bonded to the bearing surface of the rings. It reduces wear so much that Hellcats fly five times as many hours between engine overhauls. Rings processed with PORUS-KROME are supplied for Hellcats and other United Nations planes by Koppers Company, American Hammered Piston Ring Division (a Van der Horst licensee).

PORUS-KROME . . . applied by a patented process discovered by Van der Horst . . . is also being applied in volume to many types of cylinders, bushings, and other bearing surfaces. Engine builders and users who know how PORUS-KROME is performing in war services are including it in their postwar planning.

May we discuss that subject with you?

*** PORUS-KROME is hard chromium applied by a precision process that develops pores to hold oil. Used on internal combustion engine cylinder bores, piston rings, or other bearing surfaces, it reduces wear, corrosion and scuffing, greatly multiplying engine life.**

VAN DER HORST TRADE MARK

PORUS ★ KROME

Multiplies Engine Life

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6" Ajax machine forging sockets in two ends of female member of Di-Lok Chain

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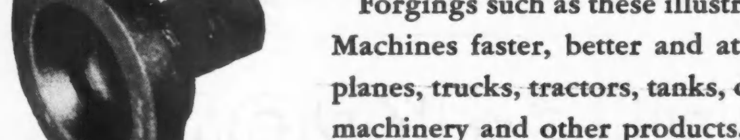
★ Industrial Progress in almost every field of manufacture is requiring products of greater strength and toughness that can be produced to close tolerances on a high production basis. Forgings provide the great strength required, due to the grain flow being refined and shaped to the contour of the product in the forging die.

Uniformity, at a high degree of accuracy, is provided by AJAX Forging Machines due to their sound mechanical construction embodying many exclusive, patented features.

High speed production on AJAX machines is accomplished by the patented direct acting air clutch providing instantaneous response to the operation of the treadle.

Forgings such as these illustrated are being produced on AJAX Forging Machines faster, better and at less cost for manufacturers of ships, airplanes, trucks, tractors, tanks, diesels, ordnance, locomotives, agricultural machinery and other products.

Write for Bulletin 65-B



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Chicago Rawhide "Perfect" Oil Seals are serving effectively in this capacity in practically every country of the world, in the air, on the sea, and throughout industry.

No matter where it may be or how difficult the operating conditions, Chicago Rawhide "Perfect" Oil Seals offer the most effective bearing protection.

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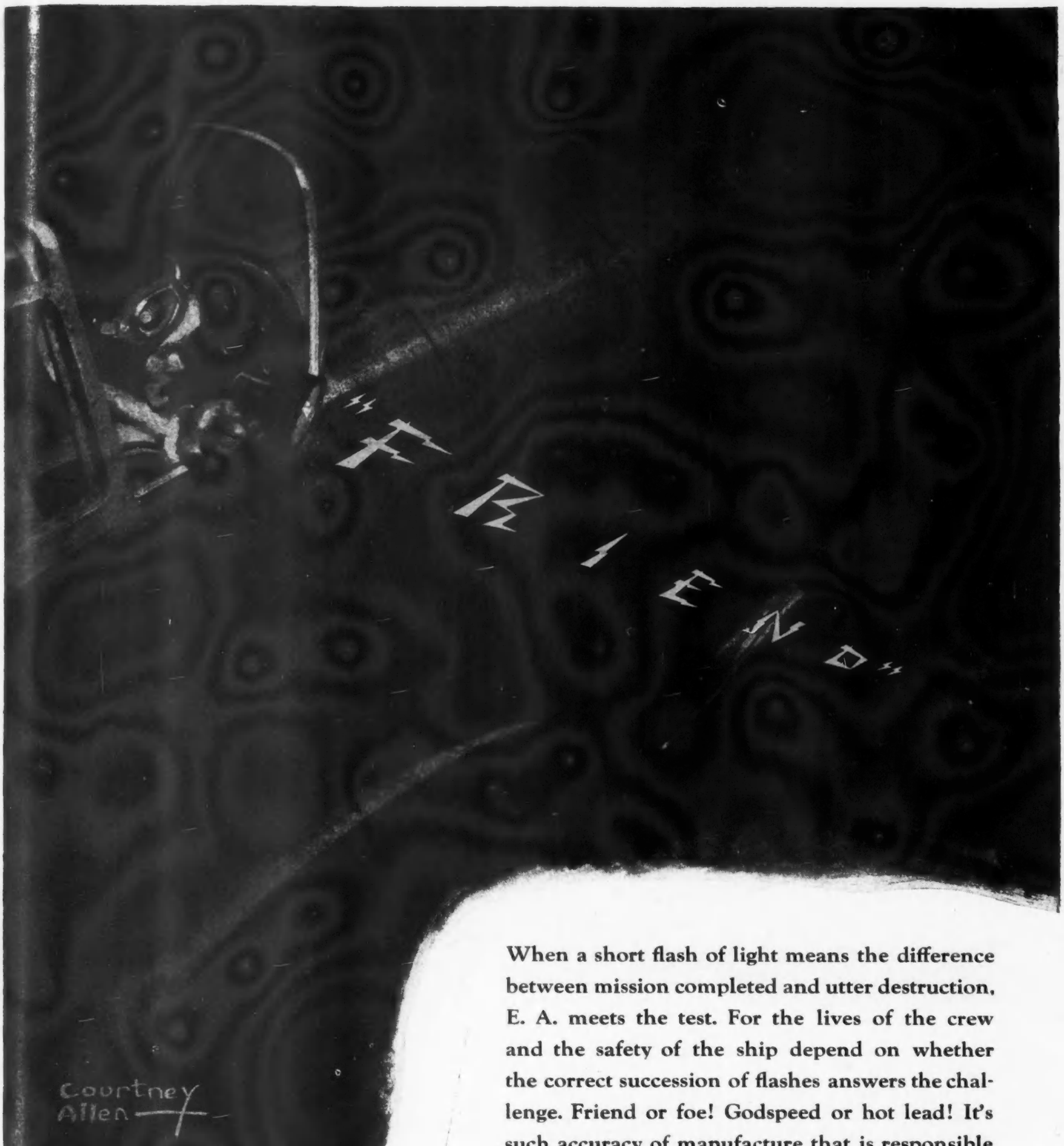
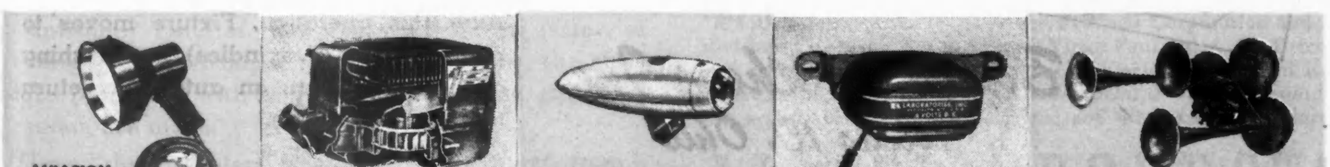
★

65 Years Manufacturing Quality Mechanical Leather Goods Exclusively and now Sirvene Synthetic Products



When a short flash of light means the difference between mission completed and utter destruction, E. A. meets the test. For the lives of the crew and the safety of the ship depend on whether the correct succession of flashes answers the challenge. Friend or foe! Godspeed or hot lead! It's such accuracy of manufacture that is responsible for E. A. Laboratories' leadership in the many industries it serves.



E. A. LABORATORIES, INC., BROOKLYN, N. Y.

MAKERS OF AUTOMOTIVE, AVIATION, BICYCLE AND MARINE APPLIANCES

Again, BAKER Contributes to Current High Aircraft Production

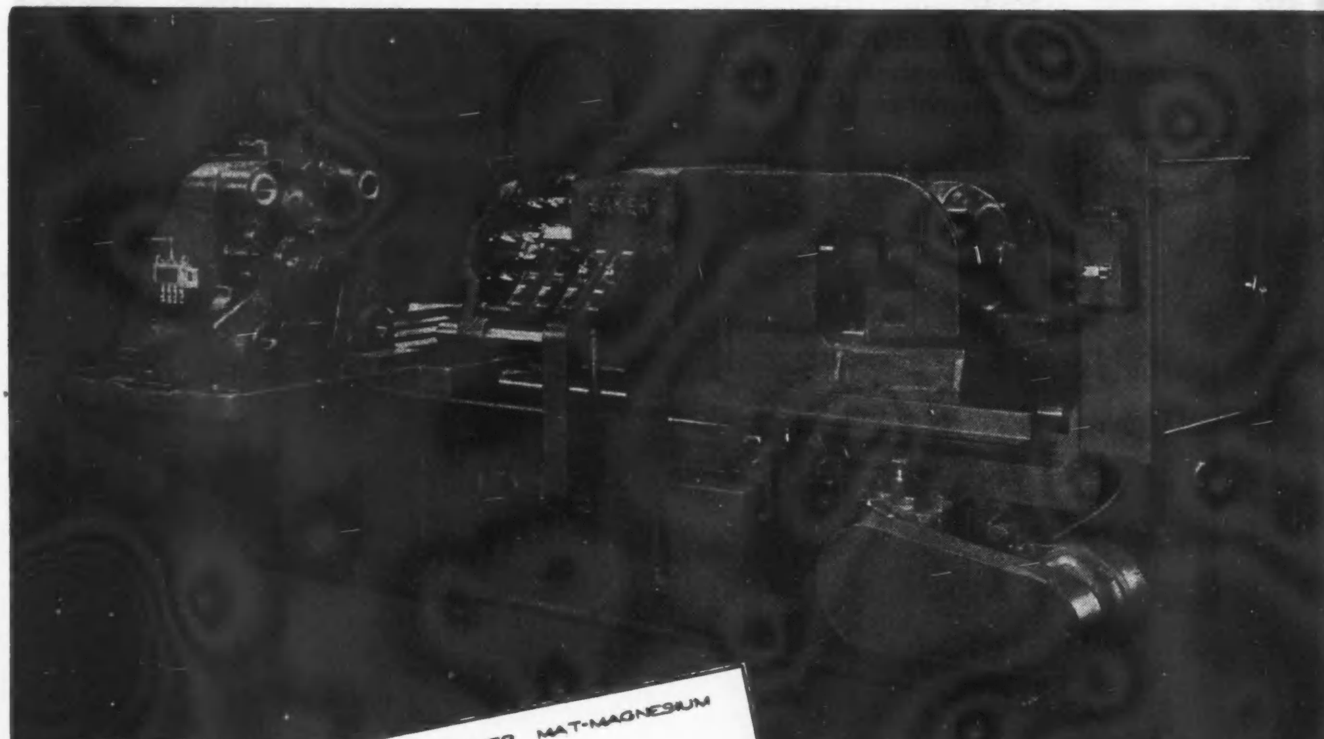


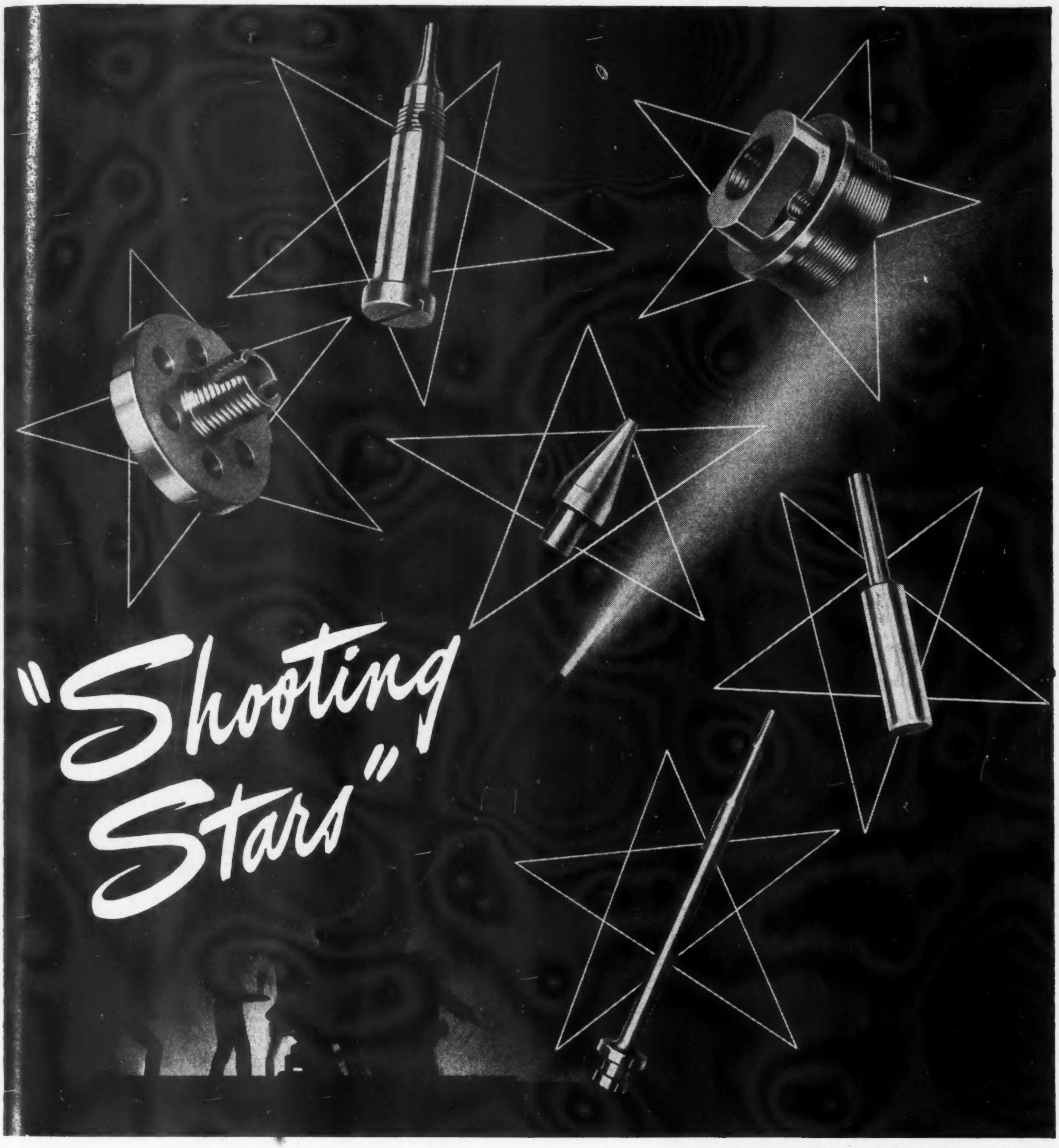
ILLUSTRATION shows the Fixture to front at Chucking Position. The operator loads, unloads, and pushes button to start cycle.

Fixture and work automatically index to 1st (Front) Position (8 Spindles) for drill and rough bore.

After this operation, Fixture moves to rear position (7 spindles) for finishing operations. Then, an automatic return to chucking station.

Baker Brothers, Inc.
Toledo 10, Ohio

BAKER


"Shooting Stars"

THE SUN NEVER SETS ON THE MIGHTY JEEP

NOR ON N-A-X HIGH TENSILE

Hell Bent for Victory

WITH N-A-X HIGH TENSILE

Slugging it out in the devilish nightmare of modern war . . . pounding ahead through blistering heat and paralyzing cold . . . the Willys Reconnaissance Car—the Jeep and N-A-X HIGH TENSILE Steel is a fighting team of solid American might.

Superior implements of war like the amazing Jeep are crushing Axis resistance on all fronts . . . and in practically every type of battle equipment used by the Allies, you will find steel by Great Lakes. Such service-testing by any machine or metal should be conclusive evidence of its ability to meet all civilian needs. It certainly demonstrates the rugged strength and resistance to fatigue and impact of N-A-X HIGH TENSILE. Write for our new booklet describing N-A-X HIGH TENSILE and N-A-X 9100 SERIES of alloy steels. It gives you complete details.

DUCTILITY — ITS INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE — STRENGTH

GREAT LAKES STEEL CORPORATION

DETROIT, MICHIGAN . . . *Sales Offices in Principal Cities*

Division of

NATIONAL STEEL CORPORATION

Executive Offices *Pittsburgh, Pa.*

SURFACE FACTS ABOUT METALS

First of a series of articles on the preparation of metal surfaces for protective finishes

ALROK* TREATMENTS

OF ALUMINUM AND ALUMINUM ALLOYS IMPROVED BY ACP DEOXIDINE PROCESS

It has recently been established that the appearance as well as the effectiveness of Alrok coatings can be greatly improved by the use of **DEOXIDINE**, a phosphoric acid type cleaner, instead of the alkali solutions formerly used to prepare the aluminum and aluminum alloy parts for the treatment. **DEOXIDINE #170** for immersion processes and **DEOXIDINE #10E** for spray operations are used in water solutions in accordance with regular metal cleaning practice.

Aluminum oxidizes rapidly; but, unlike steel, the resultant oxide forms a protective coating that retards further corrosion. In the Alrok process, a uniform oxide coating is developed, chemically, which both protects the metal and changes and improves its appearance. The object and benefit of the Alrok process is to obtain a uniformity of the oxide coating. In order to secure this, it is absolutely necessary to have a precleaning system that will present uniform, chemically clean, and receptive surfaces to the oxide-forming baths.

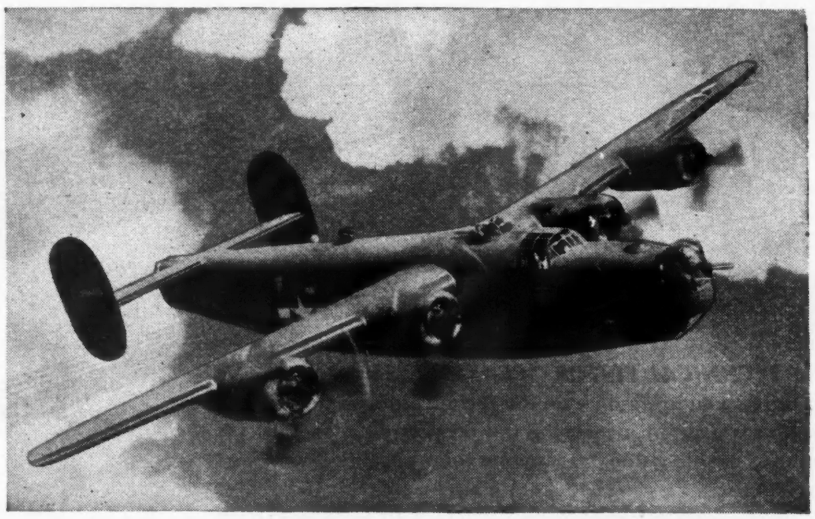
Alkali cleaners which, generally, for this purpose are inhibited with sodium silicate, produce a surface that retains traces of silicate and this results in irregularities in the surface appearance of the Alrok coating. In certain instances, the formation of the Alrok coating is completely prevented.

In some plants the alkali cleaning operation is followed by a water rinse after which the parts prior to Alroking are etched in a heated chromic-sulphuric acid bath for from 3 to 5 minutes and again rinsed in water. The resultant Alrok coating contains sulphate ions ($SO_4^{=}$), traces of which remain on the surface as a result of the chromic-sulphuric acid pickle. While a uniform Alrok coating is thus obtained, these traces of sulphate ion are detrimental, since they accelerate corrosion and hence will adversely affect the life of any subsequent paint finish.

The Deoxidine process in preparation for Alroking combines the cleaning and etching operations in one solution, thus greatly reducing the time required and increasing the production capacity of the finishing department. The cleaning and the more uniform etching is more effectively accomplished without objectionable or corrosive fumes and, after a water rinse, the parts take a more uniform and durable Alrok coating. The trace residues of the Deoxidine process (phosphates, if left) are anti-corrosive agents that improve rather than impair the life of paint finishes subsequently applied.

The success of Deoxidine for cleaning aluminum and aluminum alloys is but one example of the successful use of Deoxidine for cleaning metals (except zinc and cadmium) in properly preparing them for paint. The thorough cleaning is chemical as well as mechanical and residues, if left, are beneficial to paint life rather than harmful. There are various grades of Deoxidine adapted to the various methods of application and different conditions of the surface.

*Reg. T. M. Aluminum Co. of America.



Chemically Clean Surfaces for Lasting Metal Finishes

Deoxidine method is adapted to cleaning all aluminum, aluminum alloys, steel or other metals (except zinc or cadmium).

Today it is more essential than ever before that aluminum and other metal parts used in construction of aircraft, automotive vehicles and other fighting equipment should be *chemically clean* before the protective finish is applied—else damage from oxides and rust may cause irreparable damage.

There are various grades of Deoxidine suited to the several methods of application and to cleaning where varying amounts of oxides, rust, scale and oil are present.

Our technicians are available to adapt Deoxidine or other ACP Products to your individual production problems. Time will be saved if you will give us as complete details as possible concerning your methods and requirements.

Manufacturers of Inhibitors & Metal Working Chemicals

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

Note—West Coast Plants may address inquiries and orders for prompt delivery to Leon Finch, Ltd., 728 East 59th St., Los Angeles, California.

AMERICAN CHEMICAL PAINT COMPANY, AMBLER, PA.

Please send me general Technical Service Data Sheets on ☐ *Deoxidine #170*

Name ______ Title ______

Company ______

Address ______

K-3

This modern brake provides ample braking power to control heavily loaded cargo trailers of the largest size.

Its electro-magnet lever action develops a tremendous braking torque in proportion to the size of the brake.

Because it is electrically operated, the action of the Magdraulic Brake is instantaneous and the braking effect is always smooth.

The brake is a self-contained unit, with no exposed parts to be damaged or to get out of adjustment. It permits full clearance under the vehicle on which it is used, because it requires only a wire from the controller to each wheel.

Today the Empire plants are fully engaged in war production, supplying brakes for essential uses. In the peace to come Magdraulic Electric Brakes will be available in various sizes, suitable for all types of trucks, trailers and passenger cars.

DESCRIPTIVE BULLETIN WILL BE FURNISHED ON REQUEST

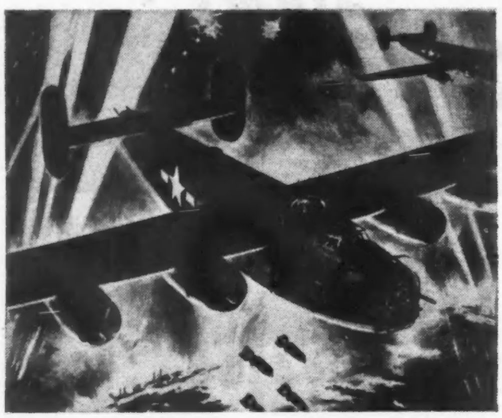
ELECTRIC EMPIRE BRAKE CO.

South 14th Street — Newark 7, New Jersey

Manufacturers of MAGDRAULIC ELECTRIC BRAKE • VACDRAULIC BRAKE POWER BOOSTER AND EMPIRE STEERING BOOSTER AND STABILIZER

This advertisement is one of a series which is appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of transportation's role in the war, and its postwar opportunities and responsibilities.

As a Liberator pilot put it:
"One of their cities is missing!"



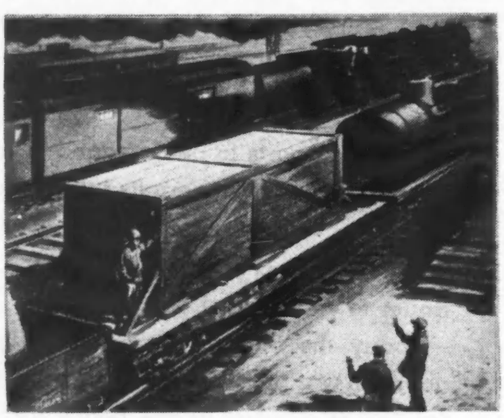
1,600,000 gal. gasoline
60,000 gal. oil
3,250,000 rounds machine gun ammunition
4000 tons bombs
300 tons food
46 complete bombers lost
426 bomber engine replacements
75 tons other replacements: tires, armament, parachutes, radios, wing sections, instruments, oxygen tanks, bomb sights, etc.

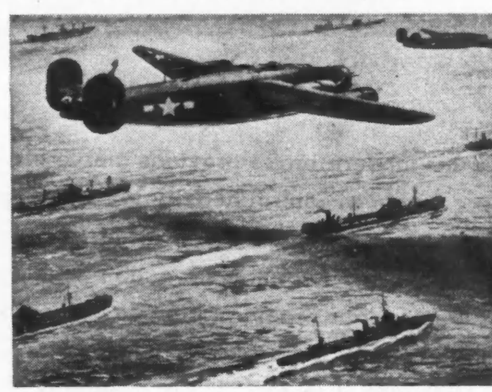
(The figures given above are approximate)

1. 40 minutes ago, there were Nazi factories down there building Focke-Wulf 190's and machine guns. Now there are no factories. Not even a city. For the last of 1000 Allied bombers has just dropped its block busters and is heading for home.

Back of this 1000-bomber sweep is a story not many people know—a story quite apart from that of the heroism and sacrifice of the bomber crews. It has to do with the terrific problem of supply in waging aerial warfare. For example...

2. Above, you get a rough idea of the cost, *in material alone*, to send 1000 4-engine bombers over Germany. How can Bomber Command get *another* 300 tons of food...*1 day's supply for the 150,000 men it takes to put 1000 bombers over the target?* Another 160 tank cars of aviation gasoline? Another 4000 tons of bombs? Not just for tomorrow, but for the next day, and the next. *Answer:* That's where Air Power's three teammates come into the picture—the train, truck, and ship . . .





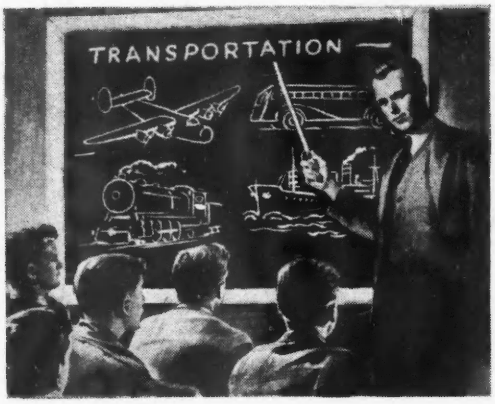
3. If your sleeper is shunted to a siding, remember this: It is probably being held up to let a fast freight streak through — tank cars of gasoline, cars loaded with spare bomber parts, engines, crates of nested bombs, tons of food, ammunition, and all the rest. Getting Bomber Command's supplies from factory to seaboard is the first lap in a 1000-bomber attack on Germany. And in this relay race to Victory, the railroads of America are doing a magnificent job!

4. Slogging along at a snail's pace, protected by anti-submarine Liberators, a never-ending convoy of cargo ships and tankers becomes the life stream of Air Power. They bridge the Atlantic with supplies and replacements to *keep* the bombers fanning out over Germany. This link in the chain of supply must never be broken. If a cargo is sunk on the way over, Air Service Command and the Navy move heaven and earth to get an exact duplicate cargo loaded into another ship and on its way within 48 hours!

CONSOLIDATED VULTEE

5. The truck, wherever you find it, is Bomber Command's most versatile workhorse. In the U.S., along with the railroads, it delivers the goods to the convoys. At the hundreds of British air bases from which the 1000 bombers took off, again it is the truck that lugs in the gas, bombs, food, spare parts, and so on. And as a final gesture, the truck gasses-up the heavy sluggers before they take off on their mission.

IN THIS DRAMA of train, ship, truck, and plane pitching in together to help speed the defeat of the Axis, there is a lesson *we must not forget* when the war is over:



6. Out of this war will come *improved, cheaper,* and *swifter* ways of transporting goods and people—over highway and rail, on the sea, and through the air. In rebuilding the peacetime world, ***all these forms of transportation must work together,*** each doing the job for which it is best fitted.

And the plane will have still *another* responsibility. Having linked once-remote nations together into a 60-hour-wide world, it can play a vital role in *enforcing* global peace.

In short, a postwar aerial police force is America's best assurance that the peace so dearly won will not again be violated at the whim of aggressor nations.

QUICK FACTS FOR AIR-MINDED READERS:

Without war paint — Covering the gleaming aluminum surface of a Liberator bomber with camouflage paint adds 180 lbs. to its weight, cuts down air speed about 8 m.p.h. *Recent AAF decision:* No more camouflage on combat planes. Speed, plus added armament, provides greater protection to combat crews.

• • •

And more in '44! Aircraft production figures for '43 show that Consolidated Vultee is now the world's largest producer of airplanes. The company delivered more than 126,000,000 pounds of aircraft last year, including spare parts. This represented 12% by *number* and 16% by *weight* of all aircraft built in the U. S.

• • •

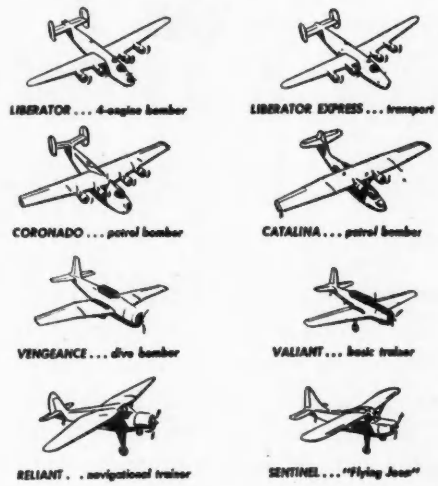
What does it cost to fly? In 1927, air transport passengers paid 13¢ a mile. Today it costs only about 5¢ a mile to travel by air.

• • •

14 to 1—Before the war it required the equivalent of 1 year's labor for 100 Consolidated Vultee workers to build one Liberator Bomber. In 1941—a year's labor for 35 workers. In 1942—for 12 workers. Last year, and today—7 workers, or less. In other words, the same amount of direct labor that was formerly required to build one Liberator now builds 14.

No spot on earth is more than 60 hours' flying time from your local airport

From "Flying Jeeps" to Leviathans of the air—*Consolidated Vultee Aircraft Corporation now builds many types of war planes, from small trainers to long-range bombers. When peace comes, the company will be in a position to provide the postwar equivalent of such planes, from small, privately owned "air flivvers" to huge transoceanic cargo-and-passenger planes.*



AIRCRAFT

San Diego, Calif.
Vultee Field, Calif.
Tucson, Ariz.
Fort Worth, Texas
New Orleans, La.
Nashville, Tenn.
Louisville, Ky.
Wayne, Mich.
Dearborn, Mich.
Allentown, Pa.
Elizabeth City, N. C.
Miami, Fla.

Member, Aircraft War Production Council

Broaching by *American*

PROVEN in war . . .

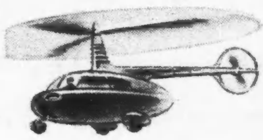
Ready for PEACE

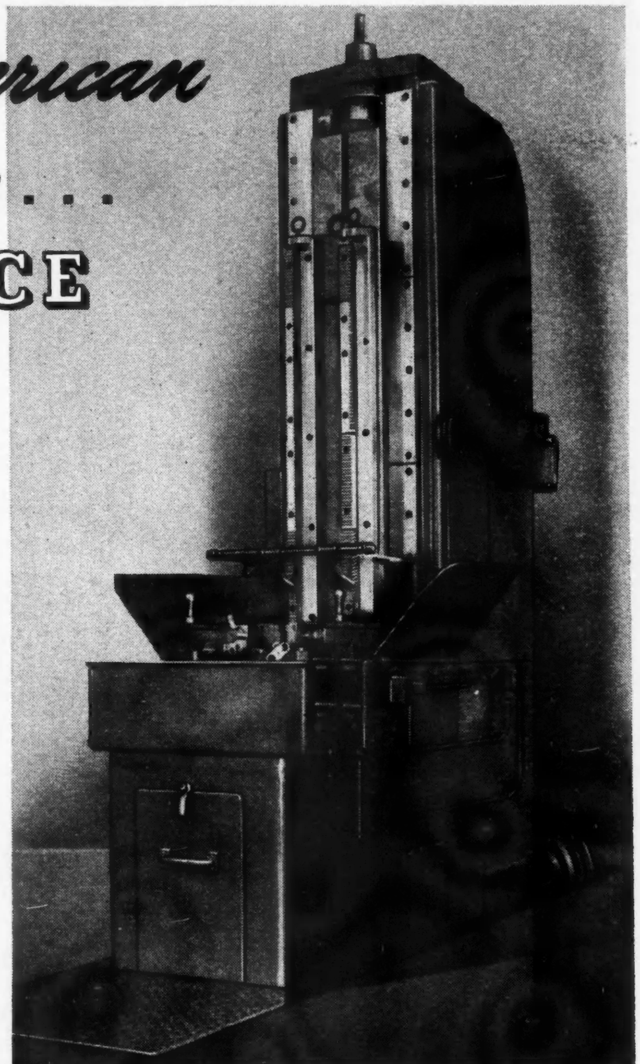
When war's demands made necessary precision production on a mass production basis, many leading production engineers turned to broaching—by *American*.

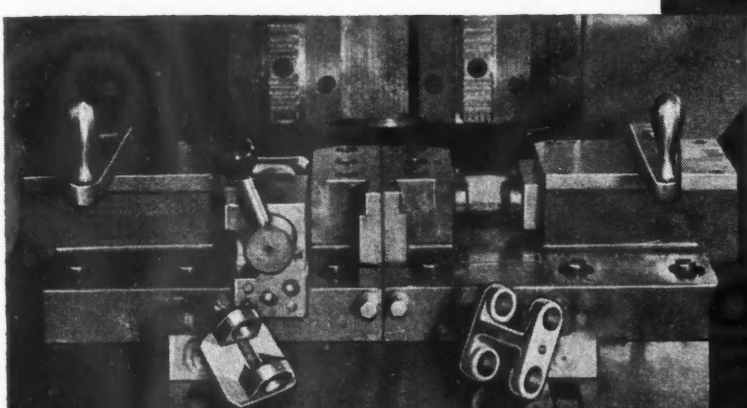
A typical example: finishing the surfaces between the bosses on aircraft universal joint parts. American Broach and Machine Company engineers—identified with broaching since the turn of the century—assumed responsibility for complete broaching equipment for this job. An *American* SB-54-10 single ram machine with receding work table was provided, equipped with a two station fixture designed to broach two end parts and one center part for a balanced production in each two machine cycles. (See illustration below.)

This is but one of the many war jobs where broaching by *American* is providing faster, more accurate and more economical production. When production planning is undertaken for peacetime products, *American's* complete service—machines, tools, and engineering—will be available.

Broaching is better the *American* way — proven in war, ready for peace!







(Above) *American* SB-54-10 Machine. Loading and unloading are synchronized with the machine cycle so that down time is zero . . . production high . . . finish excellent.

(Left) Parts broached in this operation are shown installed in the fixture, with two completed parts lying on the front of the table.

Use proper and sufficient lubrication when broaching. It is cheap life insurance for broaching tools.

American

BROACH AND MACHINE CO.

ANN ARBOR, MICHIGAN

BROACHING MACHINES
PRESSES
BROACHING TOOLS
SPECIAL MACHINERY

DIVISION OF

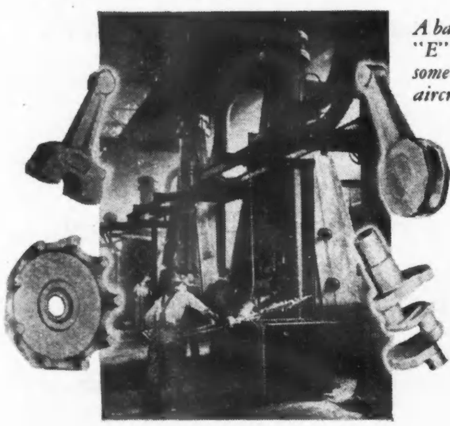
MEETING THE "UNPREDICTABLE"

OFFICIAL U. S. NAVY PHOTO

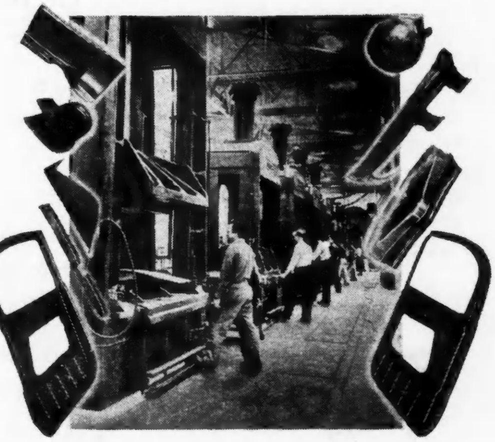
WHY DROP FORGINGS AND CECOSTAMPINGS ARE A WAR TIME "MUST"

THE DEMANDS of war are ruthless—nothing can be left to chance. When the ability of a metal part to stand up under battle strain is being calculated, the war time designer must allow for "unpredictable" stresses and strains. That is why the demand for drop forgings in this war has risen to heights heretofore undreamed of—why drop stamped sheet metal parts of light weight and high tensile strength (Cecostampings) are required in unbelievable quantities. Drop forgings and drop stampings have the extra strength combined with light weight, that makes all the difference between success and failure in the performance of airplane, tank, gun, or other mechanized piece of battle equipment.

Chambersburg Hammers and Cecostamps are contributing heavily to the veritable torrent of drop forged parts and Cecostampings that are going into the mechanized forces of the Allies pressing forward on every battle front. These Hammers and Cecostamps will be contributing as heavily in the days of Peace that are ahead—if the lesson taught by war is remembered . . . the lesson that there can be no substitute for the strength, toughness and light weight imparted to metals by impact die-forming.



A battery of Chambersburg Model "E" Steam Drop Hammers and some typical drop forgings for aircraft engine parts.

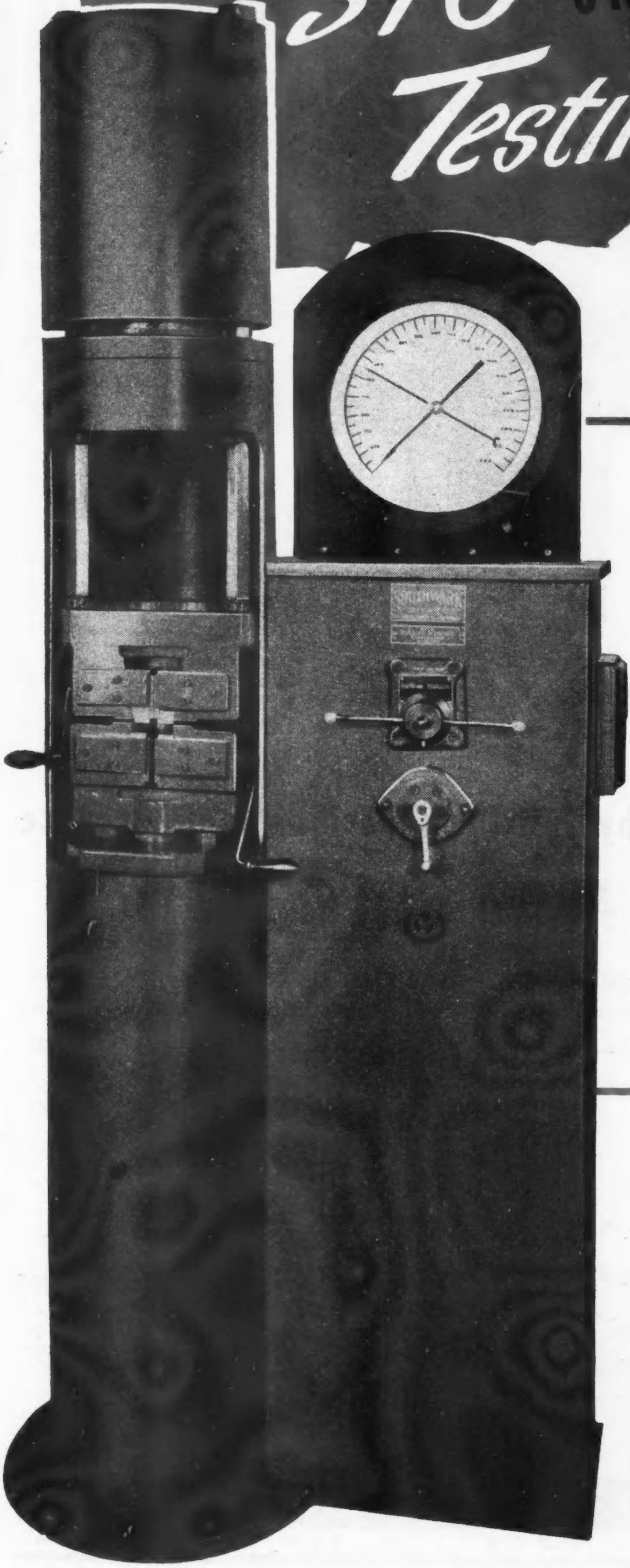


A battery of Chambersburg Cecostamps and typical Cecostampings for aircraft fuselages, doors, exhaust pipes, etc.

CHAMBERSBURG ENGINEERING CO.

CHAMBERSBURG, PENNSYLVANIA

S-10 UNIVERSAL HYDRAULIC Testing Machine



★ MODEL S-10-A 4,000 LB CAPACITY
★ MODEL S-10-B 10,000 LB CAPACITY
★ MODEL S-10-C 20,000 LB CAPACITY

This is a testing machine styled to the times, well designed and finished, extremely compact, low in cost, foolproof, and broad in its useful application to shop and laboratory testing.

Outstanding Features

1 Open front grips with replaceable file inserts in the wedges.

2 Gripping heads counter-balanced and spherically suspended for axial loading, but restrained against excessive tilting while operating grip handles.

3 Lateral adjustment of lower gripping head for offset of spot-welded specimen.

4 Floating type, packless hydraulic loading cylinder.

5 Quiet non-pulsating hydraulic power unit with variable fluid discharge speed control and instantly reversible direction of head motion.

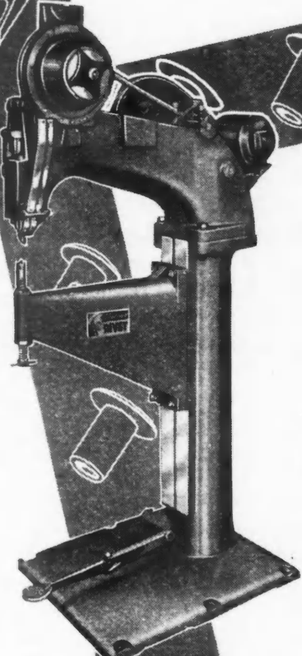
Write for Bulletin 182

THE BALDWIN LOCOMOTIVE WORKS, BALDWIN SOUTHWARK DIVISION, PHILADELPHIA, PA., U.S.A. PACIFIC COAST REPRESENTATIVE: THE PELTON WATER WHEEL CO., SAN FRANCISCO, CALIF. IN CANADA: PEACOCK BROTHERS LTD., MONTREAL.

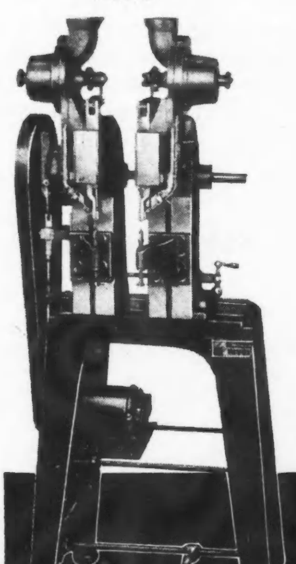
BLW THE BALDWIN GROUP

BALDWIN
SOUTHWARK
TESTING EQUIPMENT

HOW TO SET RIVETS TEN TIMES FASTER



Chicago Model 140 Automatic Rivet Setter with interchangeable rivet hopper and raceway assembly.



Chicago Model 555 Automatic Multiple Rivet Setter with adjustable riveting centers.

YOU set rivets ten times faster, and at much lower cost . . . that is conservatively estimating the result when you change from hand feeding and insertion of the rivet to Chicago Automatic Rivet Setting. In many actual sub-assembly operations the change to Chicago Automatic Riveting Machines and Tubular Rivets has increased output *twenty times!*

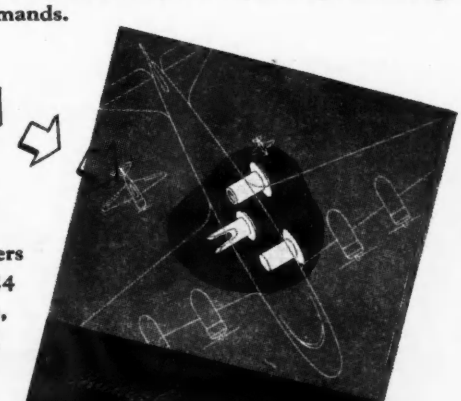
Chicago Automatic Riveting Machines are so much faster because they are truly automatic. Precision tubular or aircraft rivets are fed, inserted and clinched with each release of the operating pedal. And so simply are these machines operated that the usual schooling of operators is unnecessary.

Chicago Automatic Riveting Machines are versatile, too . . . easily changed in a few minutes to handle different sizes of rivets. And whether it is a single or multiple type Chicago Rivet Setting Machine . . . whether it has a 45-inch throat or a 6-inch throat . . . it clinches grommets and eyelets and inserts drive screws as efficiently as it sets rivets.

Faster, more efficient, more versatile, more economical . . . these are the reasons why Army and Navy engineers fully approve Chicago Automatic Rivet Setting with Tubular and Aircraft Rivets . . . and why production men throughout the aircraft industry are depending on Chicago Riveting to meet today's demands.

FREE
NEW CATALOG GIVES FULL FACTS

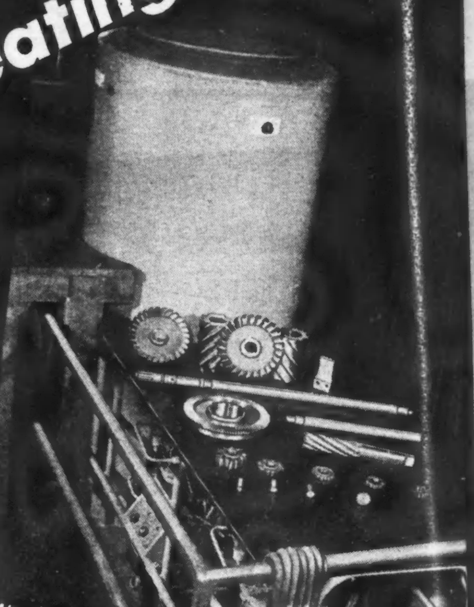
Eleven modern automatic riveters are fully described in its 24 illustrated pages. In addition, it describes the individual merits of solid aircraft, tubular and split rivets. Write for your copy now.



Chicago Rivet

CHICAGO RIVET & MACHINE CO.
9612 W. Jackson Blvd., Bellwood, Ill. (CHICAGO SUBURB)

Proof of Increased Tool Life Through this New Cold Treating Process



(Above) A few cold treated tools and machine parts are shown o table of Deepfreeze Cascade —120° F. Industrial Chilling Machin

High Speed Drill Life Increased from 48 to 256 Holes per Grind by Sub-Zero Treating

Many well known manufacturers today are obtaining remarkable increases in tool life by cold treating high speed cutting tools in Deepfreeze Industrial Chilling Equipment. Tests reveal that subjecting high speed tools to temperatures of −120° F. in a Deepfreeze Cascade Industrial Chilling Machine for a period of from two to three hours causes a decomposition of any retained austenite to martensite. This transformation results in a greater uniformity of hardness and often increases the hardness. In either case the results obtained invariably show an increase in the life of the cutting edges.

Among the many cold treating tests conducted by a large and prominent machine tool manufacturer is the treating of high speed drills used to drill four 11/32″ diameter holes in a yoke lever part made from S.A.E. 4340 steel forging with the Brinell of 387. Using a special two-spindle opposed head machine, this operation is performed at spindle speeds of 450 r.p.m. with a feed of 5″ per minute.

Before cold treating in a Deepfreeze, the best possible performance of these drills was 48 holes per grind. Now, after treating for two hours at −120° F. in a Deepfreeze Industrial Machine, the average results are 256 holes per grind, or an increase of over 500%.

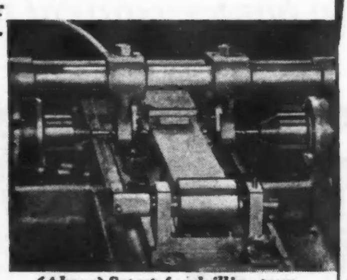
This is but one of the many outstanding results obtained by the cold treating of tools in this plant. On a gang milling operation on another yoke lever, cutters were formerly changed every 7 hours for grinding, while now after cold treatment these cutters will run 24 hours before grinding is necessary.

Pieces of tool steel from old and broken milling cutters are salvaged and reclaimed into bits which are welded to a slotting tool for cutting a guide slot ¾″ x¾″ x 30″. Previously, the best possible results were 25 to 52 slots per grind with carbide tipped tools. After cold treating these reclaimed bits for two hours at −120° F. in the Deepfreeze machine, an average of 119 slots per grind was obtained.

"We Cold Treat All Tools Now Before Using"

This manufacturer now requires that every cutting tool that comes into the plant be cold treated before it is used, and also that all cutters be cold treated after sharpening to restore original hardness of the actual cutting edges that may be slightly softened during resharpening operations. Every user of cutting tools can obtain similar increases in tool life by cold treating. If you do not now have a Deepfreeze machine in your own plant, insist upon cold treated tools from your tool supplier. Experience in this and other plants has shown that cold treating even results in increased tool life with new cutters.

Find Out How You Can Use Deepfreeze Chilling Machines in Your Plant... For the complete and latest data on the use of cold treatment of metals in industry today, get this new Deepfreeze Metal Chilling Booklet. It contains complete details, specifications and lists other applications of Deepfreeze Chilling equipment. Write for your free copy today.



(Above) Set-up for drilling four holes in yoke lever part with cold treated tools.

Read What One Manufacturer* Says About Cold Treating of Cutting Tools

After experiencing this increased hardness on Deepfreeze frozen parts, we conceived the idea of Deepfreezing high speed tools, drills, reamers, and cutters of various sizes and types. We found that on one particular drilling job, where we were using high speed drills and obtaining from five to seven pieces per grind, after applying drills that were deep froze at 120 degrees below zero for two hours, we now obtain from thirty to thirty-six pieces per grind. On one of these continuous milling operations on this same steel job we formerly obtained ten to twelve pieces per cutter grind, and after applying cutters that were given the Deepfreeze treatment we now receive thirty-eight to fourty-four pieces per cutter grind.

We also find that the number of pieces obtained after resharpening of the tools remains quite uniform which indicates that this Deepfreeze treatment penetrates into the interior of the tool and does not merely create a surface hardness.

*Manufacturer's name upon request.

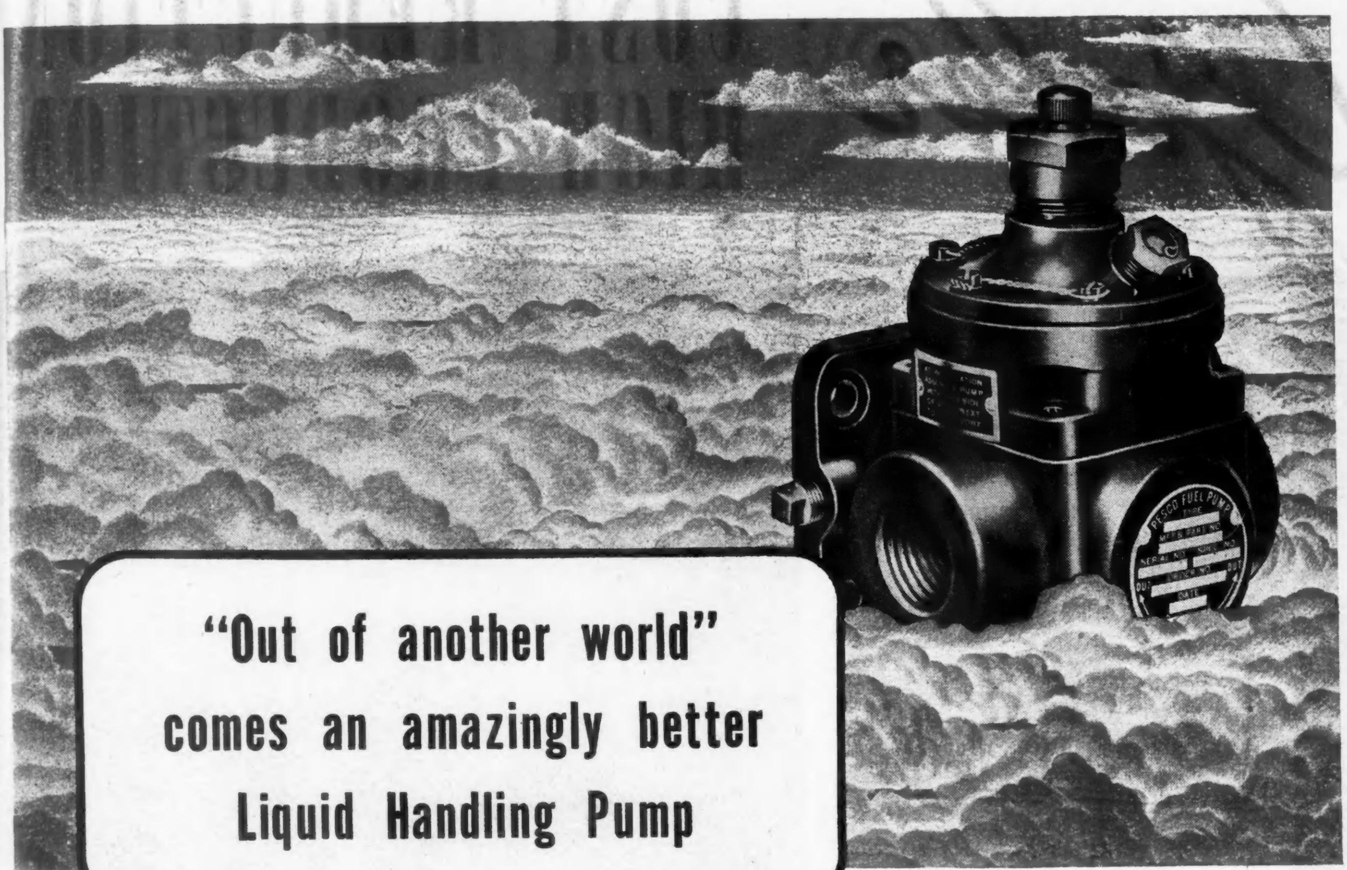
Deepfreeze

2314 DAVIS STREET
NORTH CHICAGO, ILLINOIS

TRADE MARK DEEPFREEZE REGISTERED UNITED STATES PATENT OFFICE

Industrial Chilling Equipment for Shrinking, Testing, Hardening and Stabilizing Metals

Division of Motor Products Corporation, Detroit, Michigan



"Out of another world" comes an amazingly better Liquid Handling Pump

To look at it you wouldn't see much to "ah-h" about.

It's small. Weighs less than 4 pounds. But when you note its capacity... its efficiency curve... its performance record... then you begin to take notice.

You see, we designed this pump for operation in another world, high in the heavens... in rarefied, subzero atmospheres...for planes demanding fuel to maintain speeds of five miles per minute and better.

Pesky things can, and did, happen to pumps up there. But no more... since we perfected engine-driven pumps with relief and by-pass valves that maintain efficiency regardless of temperature... since we perfected fuel pump refinements which handle "dry" high-octane aviation gasoline at close to 100 per cent volumetric efficiency... since we developed a motor-driven booster pump with a new impeller which is approximately 20 per cent more efficient on a power consumption basis than any other now in use on centrifugal pumps of equivalent size.

By mastering these and many other aircraft pumping problems, PESCO can give you fluid handling equipment of entirely new performance. Equally improved PESCO equipment is also adaptable for all types of pumping needs; hydraulic, air, vacuum and liquid. May we tell you more about PESCO Pumps and PESCO Engineering Service?

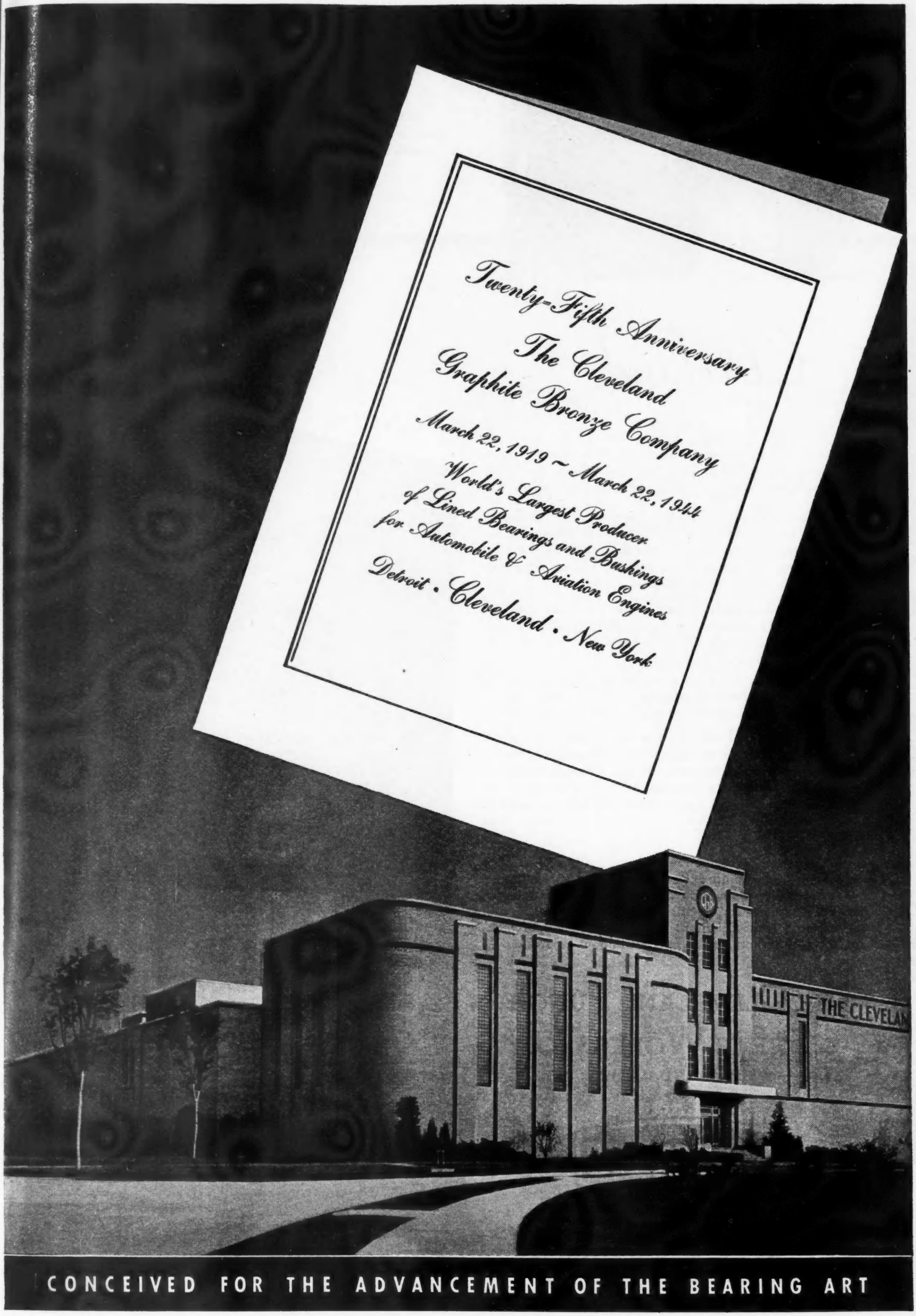
SEND FOR THIS BOOK **"Pressurized Power and Controlled Flow by PESCO". This book pictorially tells the story of PESCO equipment, manufacturing facilities and engineering service. A copy will be mailed promptly upon request.**

WRITE TO...
PESCO Products Co.
Industry Service A
11610 Euclid Avenue
Cleveland 6, Ohio

Division Borg-Warner

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories...

PERFORMANCE POINTS TO *Pesco* FIRST


Twenty-Fifth Anniversary
The Cleveland
Graphite Bronze Company
March 22, 1919 ~ March 22, 1944
World's Largest Producer
of Lined Bearings and Bushings
for Automobile & Aviation Engines
Detroit • Cleveland • New York
THE CLEVELAN
CONCEIVED FOR THE ADVANCEMENT OF THE BEARING ART

Drilling the crown of a Modern Cleveland Four Point Press.

Cleveland - Four Point

Modern Cleveland Presses embrace three distinct types known as Single Point, Two Point and Four Point, designed with one, two and four connections respectively.

On the Single Point Presses the connection is located in the center of the slide. On the Two Point Presses, there is a connection at each side of the slide and, on the Four Point Presses the connections are located at (approximately) each corner of the slide.

The gears, which run in a bath of oil, are located in the box type crown together with the drive unit and provision has been made for the easy removal of both whenever necessary.

The drive is from motor to flywheel through multiple V belts and the Press is designed to use a high speed motor which is less expensive than slower speed motors.

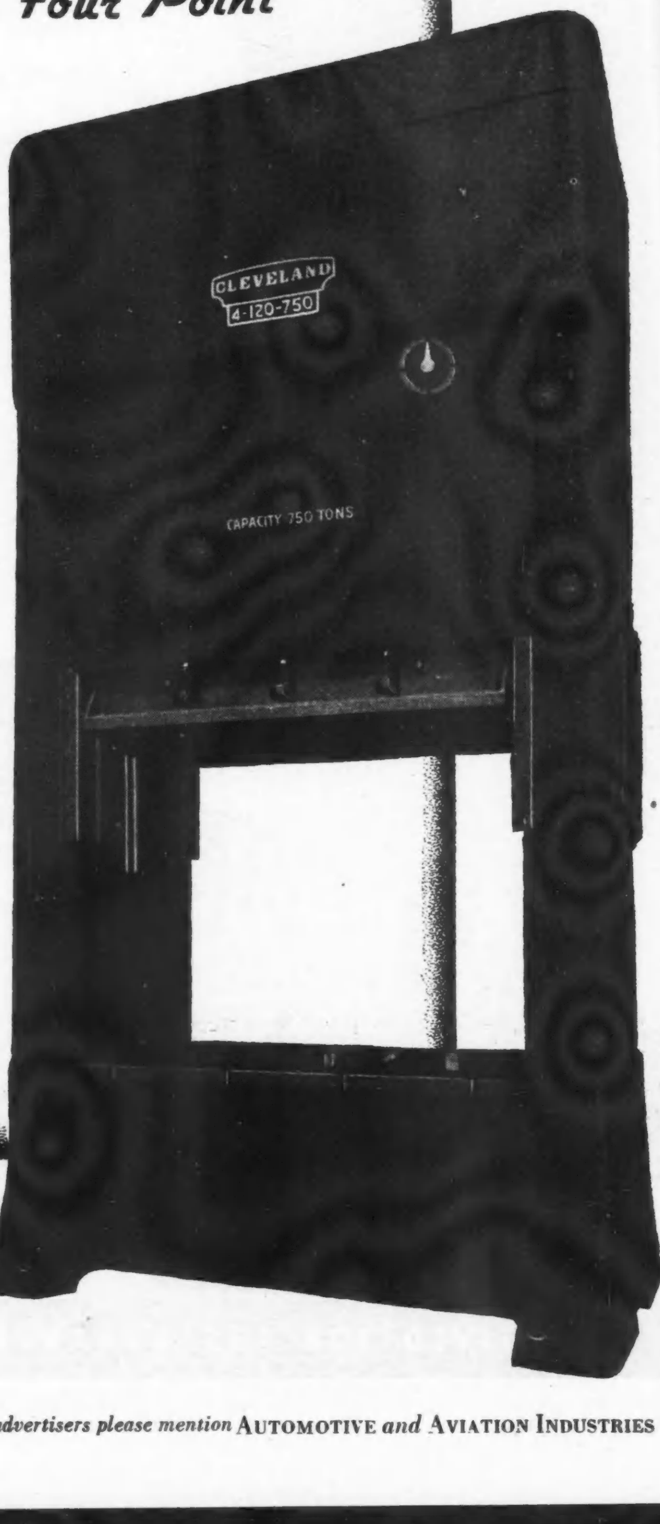
This arrangement of the gearing and drive unit in the crown eliminates the necessity for overhanging brackets or other projections and, as the Presses are symmetrical front and back, this design not only contributes to greater rigidity and ruggedness but also to general compactness with a consequent saving in overall floor space.

These Modern Cleveland Presses can be furnished in a wide range of standard sizes equipped with either a hydraulically or pneumatically operated friction clutch and brake having an electrical push button control with one or more control stations and with selector for inching, long and short stroke and continuous operation.

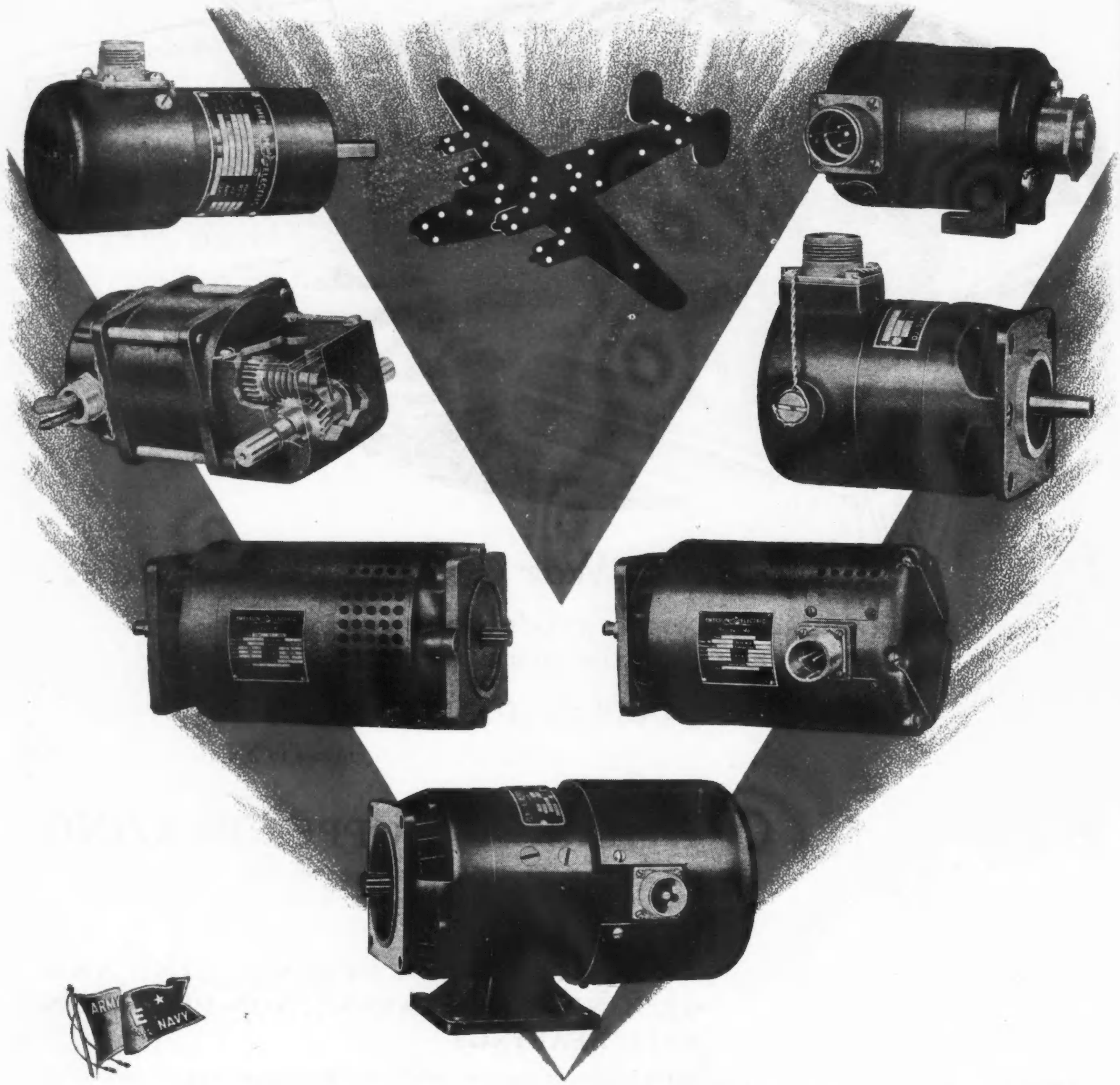
THE CLEVELAND PUNCH & SHEAR WORKS CO.

CLEVELAND, OHIO

THE
CLEVELAND
PUNCH & SHEAR WK'S CO.
U. S. A.

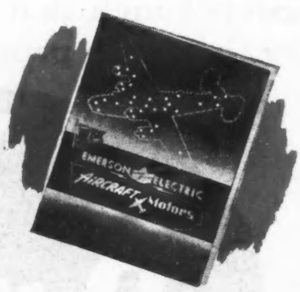


This Cleveland 4-120-750 Four Point Press had a 30" stroke, 6" adjustment, 80" x 120" bed area, and a capacity of 750 tons.



A Story That Began 13 Years Before Kitty Hawk

Thirteen years before the Wright Brothers made their first flight, Emerson-Electric was making motors. Many of the pioneer motor-driven devices for industry and appliances for the home were powered with Emerson-Electric Motors.



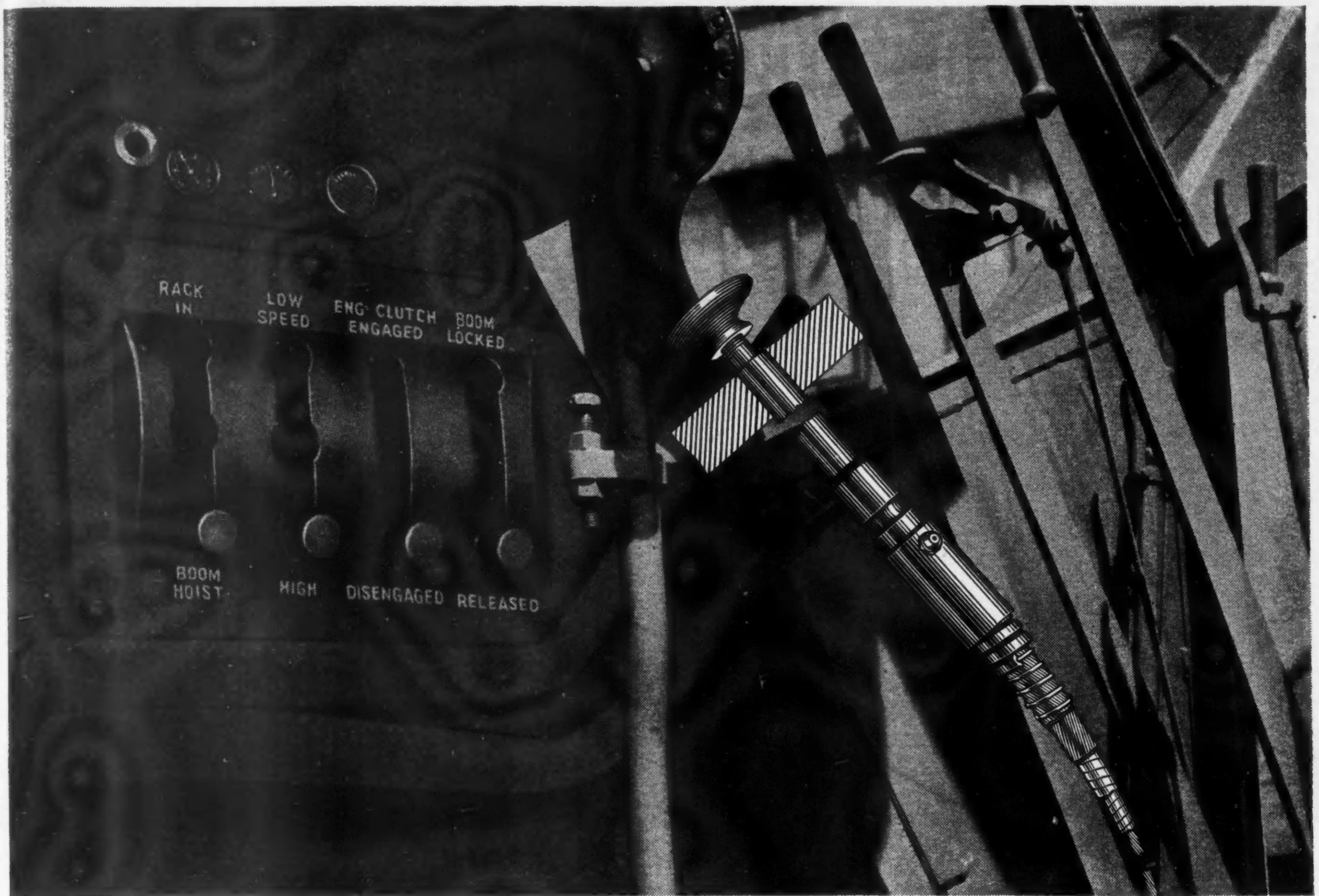
How this seasoned skill and experience was brought to aviation—how Emerson-Electric designed and is building aircraft motors for a wide range of purposes—is told in a new booklet called "Aircraft Motors", just off the press.

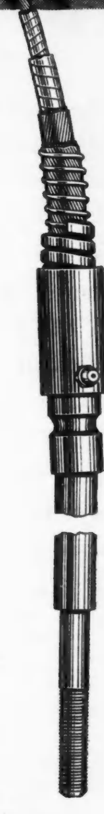
THE EMERSON ELECTRIC MFG. CO.
SAINT LOUIS (3), MO.
Branches:
New York • Chicago • Detroit • Los Angeles • Davenport

EMERSON ELECTRIC

368

MOTORS • FANS • APPLIANCES





PUSH-PULL -- an improvement in controls that you can get on your very first production

This picture of the panel in a shovel cab is offered to suggest that there is practically no job of remote control that cannot be handled efficiently by PUSH-PULL CONTROLS.

Its strength and positive action makes child's play of the control of heavy earth-moving equipment.

Yet, PUSH-PULL CONTROLS are also designed with the precision required for accurate control of fuel mixtures.

One main moving part operates, hermetically sealed, in a bath of lubricant. It is rattle-free and trouble-free for the life of the vehicle.

Easily installed because the control members are flexible enough to "snake" around parts that come between the panel and the part under control.

We will be glad to discuss the possibilities of use on your equipment, of course without any obligation.

PUSH-PULL AUTOMOTIVE CONTROLS

AUTOMOTIVE AND AIRCRAFT DIVISION

6-235 GENERAL MOTORS BUILDING, DETROIT 2 · 695 BRYANT STREET, SAN FRANCISCO 7

AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT · CONNECTICUT

In Business for Your Safety

ACCO TRADE MARK

Also manufacturers of TRU-STOP Emergency BRAKES—with ventilated discs that dissipate the heat of braking.

Why Namco Circular Chasers Cut BETTER Threads

..and LAST LONGER..

10 TO 50 TIMES LONGER

High-speed tool steel bars have their densest, toughest and purest steel close to the "skin" —around their outside diameter. That's a metallurgical fact.

So, in making Namco Circular Thread Chasers, we first cut a slice from the bar, trim off the outer "skin", machine, harden and grind the chaser—and it's ready to go.

The "business end" of the chaser—the cutting edge—is *always* located in the toughest, wear-resisting part of the steel, for the life of the chaser.

This naturally means close tolerances and maintained precision, even on high-speed production runs.

No matter how many times the chaser is reground—up to 270° of its circumference—the cutting edge is always in the best part of the steel.

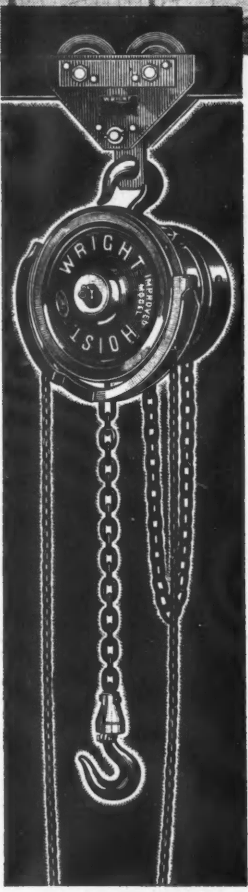
Experience has proved that Namco Circular Thread Chasers last 10 to 50 times longer. They are responsible for big cost savings in production shops that have the highest standards of accuracy.

Namco Circular Chasers are mounted on blocks set in Namco Dieheads, revolving or stationary. Replacing chasers is a 2-minute job—with no "trying for size", no spoiled work, and no variation from steady uniform production.

THE NATIONAL ACME CO.

170 EAST 131ST STREET • CLEVELAND, OHIO

ACME-GRIDLEY 4-6 AND 8 SPINDLE BAR AND CHUCKING AUTOMATICS • SINGLE SPINDLE AUTOMATICS • AUTOMATIC THREADING DIES AND TAPS • THE CHRONOLOG • LIMIT AND CONTROL STATION SWITCHES • SOLENOIDS • CENTRIFUGES • CONTRACT MANUFACTURING



Wright

cranes and hoists are your cargo planes . . .

● Up under factory ceilings, WRIGHT cargo carriers move materials fast, safely and economically —vertically or horizontally. No "ceiling zero" with efficient WRIGHT Improved High Speed Hoists, WRIGHT *Speedway* Electric Hoists or WRIGHT Cranes. Instead, ceiling areas are used to one hundred per cent production advantage.

The WRIGHT way is tailor-made to meet your problems—and to save you money. Consult your local WRIGHT distributor, who is well qualified to suggest improved material-handling methods for your plant. You will find him listed under "HOISTS" in your metropolitan classified telephone directory.

WRIGHT MANUFACTURING DIVISION
York, Pa., Chicago, Denver, Los Angeles, San Francisco, Portland, New York

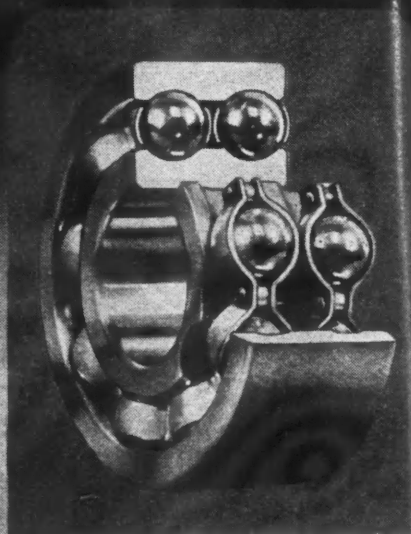
ARMY E NAVY
FLYING OVER THE WRIGHT HOIST PLANT

AMERICAN CHAIN & CABLE COMPANY, INC.
BRIDGEPORT • CONNECTICUT

ACCO
In Business for Your Safety

WRIGHT *Improved High Speed* **HOISTS**

Bearing ON YOUR POST-WAR DESIGN



Treat Bearings Right! They're in the Fight!

1. Store bearings in a dry place.
2. Do not remove the bearing from the wrapper until it is to be installed.
3. Never wash away the slushing oil on the bearing. This is a protection and the bearing is already clean when you receive it from the manufacturer.

Standardize on Standard Sizes

BCA Ball Bearings are *stable factors* in automotive design. Whatever changes you may plan, you can still rely on BCA's where you require ball bearings of sound engineering . . . careful manufacture . . . rugged construction. BCA continually studies design developments in the automotive industry.

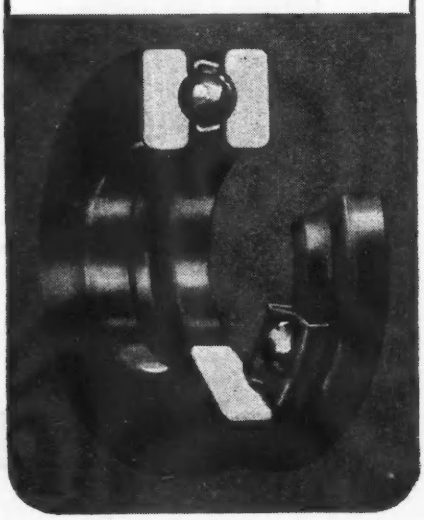
Several types of BCA Ball Bearings have been pioneered to aid in such developments. For bearing facts that bear on your post-war design, consult this alert and experienced organization. BCA will gladly help you select the proper bearings for future applications.

BEARINGS COMPANY OF AMERICA, LANCASTER, PENNA.

BCA

RADIAL • ANGULAR CONTACT • THRUST

BALL BEARINGS



For Pressing LARGE Plastic Parts

This new up-acting Birdsboro Plastic Press, with *self-contained pump unit,* is designed for the pressing of *large* plastic parts . . . and is equipped with high and low pressure pump units for fast closing and economical pressing. Available in sizes such as 600, 900, 1200 tons and larger, this press incorporates all the latest improvement features found in other Birdsboro Plastic Presses.

Once again Birdsboro engineers turn their skill to building a press to meet a specific plastic industry need. Birdsboro specialists will be glad to discuss and help solve your individual press problems. Give them a call NOW!

Birdsboro Steel Foundry & Machine Co • Birdsboro, Pa.

BIRDSBORO

HYDRAULIC PLASTIC PRESSES

We're In It To Keep 'Em Flying!!

FENN Aircraft was not organized just for the duration of the conflict . . . to keep 'em flying on battle fronts. We're in it for after the war, too. Fenn will be allied with the Aviation Industry through its post war development.

But right now Fenn Aircraft is specializing in aircraft subassemblies and parts for war planes and motors. Skill in close-tolerance production, and the "know how" to follow through with aircraft specifications and blueprints, makes Fenn a dependable source for the subcontracting of assembly line parts.

Fenn Aircraft NEW BRITAIN CONNECTICUT

DIVISION OF FENN MANUFACTURING COMPANY
MANUFACTURERS OF AIRCRAFT SUBASSEMBLIES AND PARTS

T
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The Right Combination

TO ESTABLISH DAY AFTER DAY MATERIALS HANDLING SAVINGS

NO STRAINING · · TUGGING · · PULLING NOR PUSHING with the TRANSPORTER

POSITIVE MECHANICAL BRAKE -- CONTROLS IN STEERING HANDLE -- FORWARD AND REVERSE SPEEDS -- FRONT WHEEL POWER DRIVE -- SHOCKLESS HYDRAULIC PLATFORM LIFT WITH EASY FOOT CONTROL

★

THE TRANSPORTER for horizontal movement of many more tons of material per load than by conventional methods, from receiving, to process, to storage, to shipping . . . and the AUTOMATIC Tiering Fork Truck for stacking of pallet loads, give you a modern handling system to make possible numerous daily and valuable benefits.

You lower handling costs — you do each job speedily to effect valuable time savings — you inject cost savings all along the production line—you get dependable insurance against breakage — you add safety to production — you conserve much needed floor space through high, orderly stacks which are always easily available.

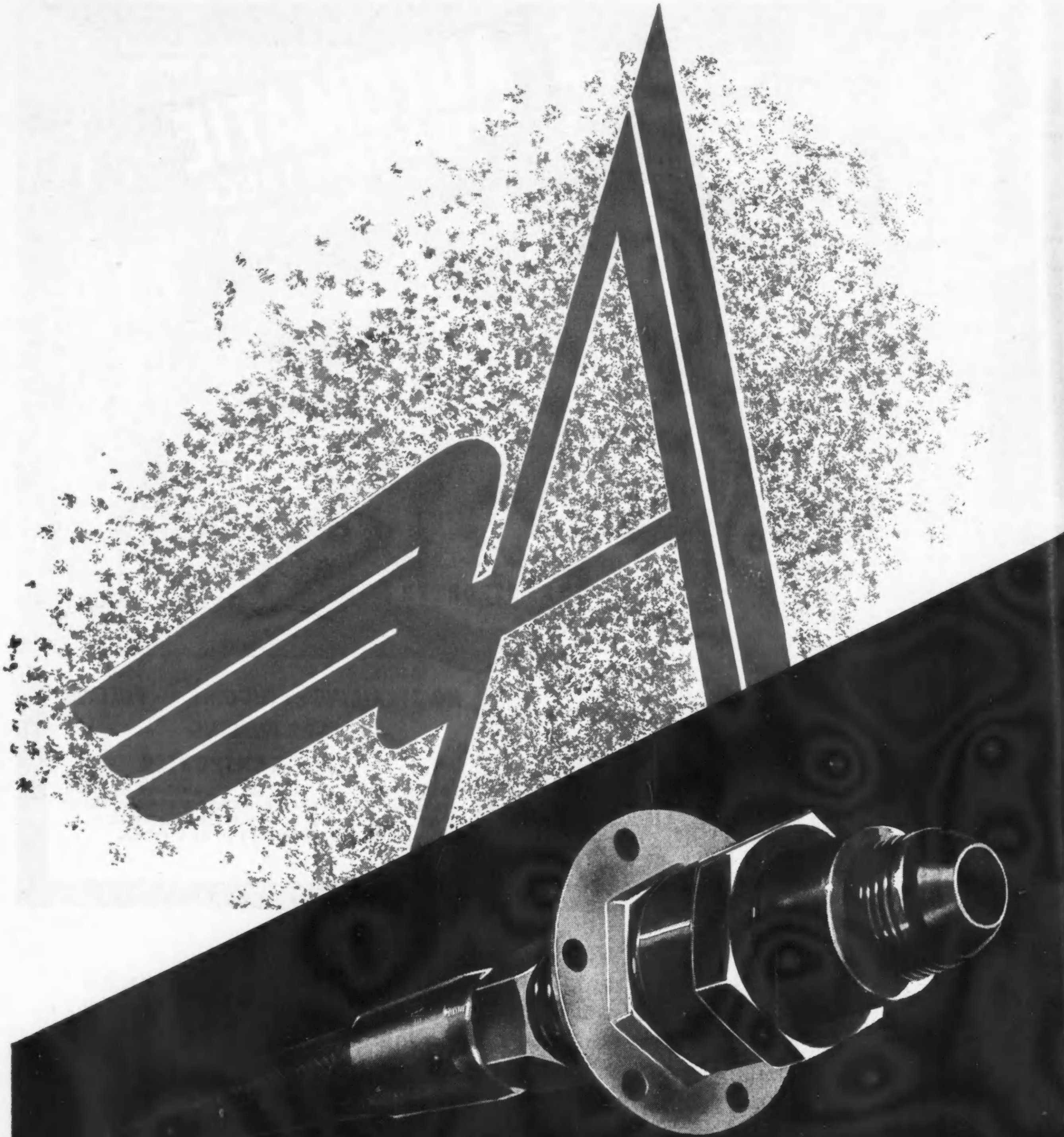
Find out the details on the employment of this truck combination for materials handling.

MANUFACTURERS FOR OVER THIRTY FIVE YEARS' *Electric Propelled* INDUSTRIAL TRUCKS

AUTOMATIC TRANSPORTATION CO.

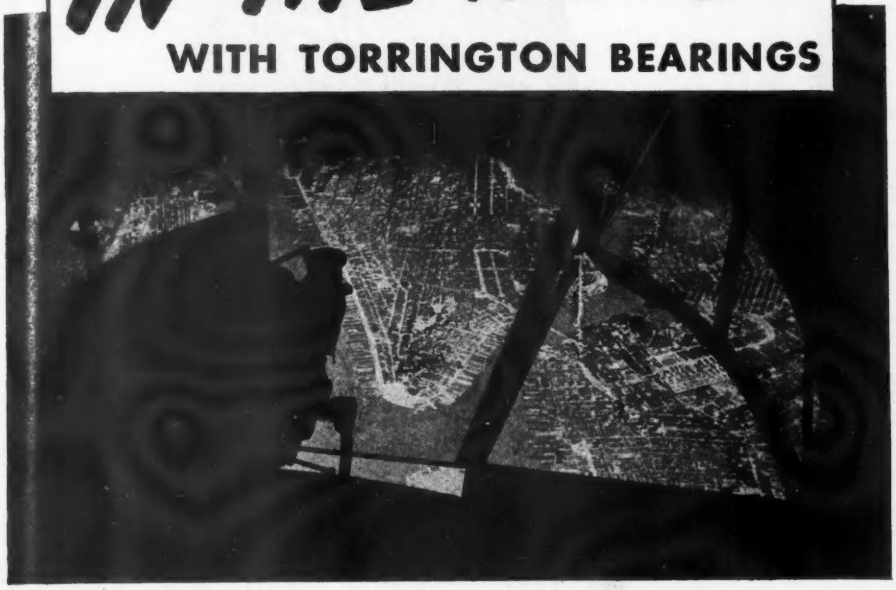
DIV. OF THE YALE & TOWNE MFG. CO.

57 WEST 87th STREET CHICAGO 20, ILLINOIS

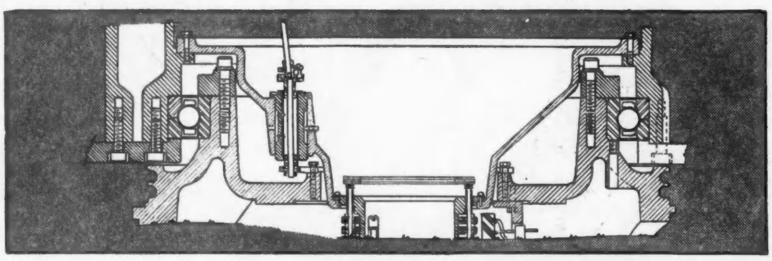


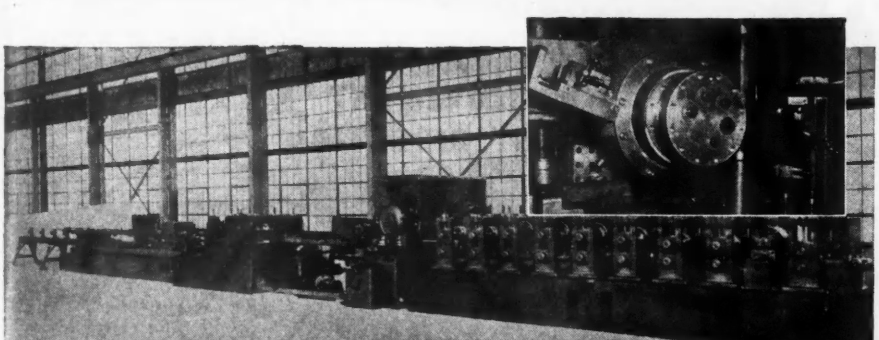
IN THE NEWS

WITH TORRINGTON BEARINGS

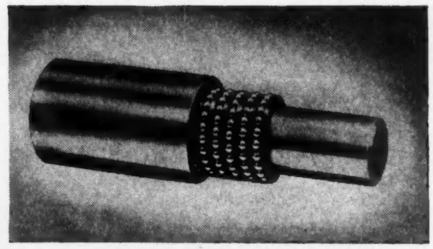


SIMULATING FLIGHT CONDITIONS, the Celestial Navigation Trainer, designed and built by Link Aviation Devices, Inc., provides operational flight crew training for navigators, bombardiers, radio operators and pilots. A fuselage which is a reproduction of a bomber nose is mounted on a universal joint and can duplicate the bank, pitch and turn of a plane under normal instrument flight. A large, 23-inch diameter ball radial bearing, supplied by Torrington's Bantam Bearings Division, helps support the fuselage, enables it to rotate with anti-friction ease and smoothness in response to the pilot's touch on controls. Photo above shows "terrain" as seen by navigator or bombardier.

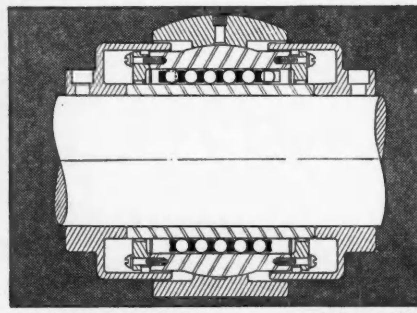




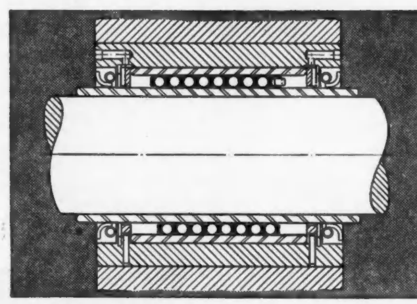
"FROM STRIP TO TUBING" describes the function of this 500 KVA Tube Welding Machine designed and built by The Yoder Company for feeding flat strip steel in, taking finished tubing out. Main electrode support shown in inset, rotates on a special 20" O.D. ball radial bearing supplied by Bantam for this "out-of-the-ordinary" application. Anti-friction bearings in every major type and in sizes up to 10 *feet* in O.D. are supplied by Torrington's Bantam Bearings Division. If you have a difficult or out-of-the-ordinary bearing job, TURN TO TORRINGTON for experienced assistance.



(1) NEW TYPE BALL RECIPROCATING BEARING that offers unusually high capacity is now available. Designed by engineers at the Bantam Bearings Division of The Torrington Company, this new anti-friction unit has a "spirally wound" retaining cage containing a full complement of balls over a long axial distance, and provides more than double the contact than heretofore available in a reciprocating bearing.



(2) NEW APPLICATIONS are expected from this new high capacity unit which offers the design engineer several advantages over the type formerly available. This X-section shows a typical mounting suggested for printing press inking rolls, designed to eliminate possibility of oil leakage.



(3) OTHER APPLICATIONS are expected to be found in engine governors, welding machine guides, doctor blades, coating machines, spool winders, buffers, polishers, etc. A number of methods of mounting are suitable, depending on existing design factors. A second suggested type is shown here.

A FULL RANGE OF NEEDLE BEARINGS to meet virtually any radial load requirement is included in the Torrington-Bantam line, as well as all major types of tapered roller, straight roller and ball bearings. Our engineers will be glad to work with you in selecting the right type for your requirements. Join the TURN TO TORRINGTON for your bearing needs.

ARMY E NAVY

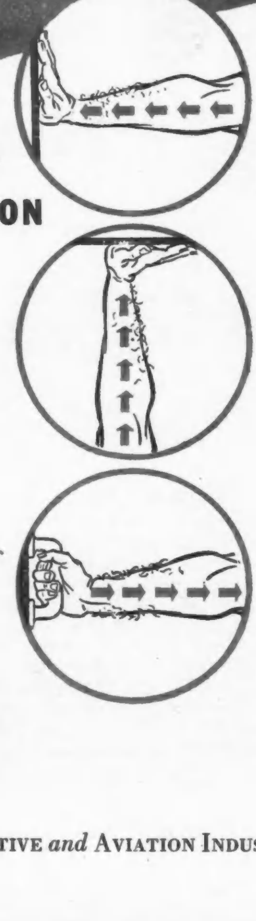
TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

FOR POWER MOVEMENT IN ANY DIRECTION



When T-J Air or Hydraulic Cylinders "take over" a job of power movement...experienced shop men know these Cylinders will deliver top efficiency in every stroke!

Whether it's a mechanical movement requiring pressure to clamp...press...raise ...or shift—T-J Cylinders do the job *right!* Designed for compactness, these Cylinders are accurately machined for correct mounting and highly efficient performance. Cylinder bores are honed to accurate concentricity, then hard chrome plated. Available in many standard sizes and styles...both cushioned and non-cushioned types. T-J engineering and skilled workmanship assure utmost dependability. Send for latest catalogs. The Tomkins-Johnson Co., Jackson, Mich.

FOR TOUGH JOBS SPECIFY T-J

TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS


POWER
TO WIN
Continental
Red Seal
Engines
CONTINENTAL MOTORS
Powerful as the Nation
AMERICA'S STANDARD
The strong surge of power which is rolling back the black clouds of war, now permits us to see clearly the light of Victory — a flaming light of liberation that foretells a new age of peace and security. In that age, Continental Engines will contribute greatly to the best needs of mankind, even as now they are shortening the war with their Power to Win.
ARMY
E
NAVY
Awarded to the Detroit and Muskegon Plants of Continental Motors Corporation for High Achievement
YOUR DOLLARS ARE POWER, TOO!
BUY WAR BONDS
Continental Motors Corporation
Aircraft Engine Division
MUSKEGON, MICHIGAN

. . . an ANTI-FRICTION WORLD

EVERY headline pulls it closer to reality—a world of new and undreamed-of comforts and economies; a world that will use and benefit from the brilliant inventive triumphs of war production; truly an Anti-Friction World. We know . . . for Aetna is taking a vigorously active part in planning and achieving it.

Scores of new products—machines and vehicles, implements and tools—will operate more smoothly, more quietly, at much lower cost; hundreds of old products will be restyled, redesigned; countless plants, exhausted by the huge burden of war production, will be revamped, rejuvenated—all by judicious application of anti-friction bearings. We have collaborated in planning many of these.

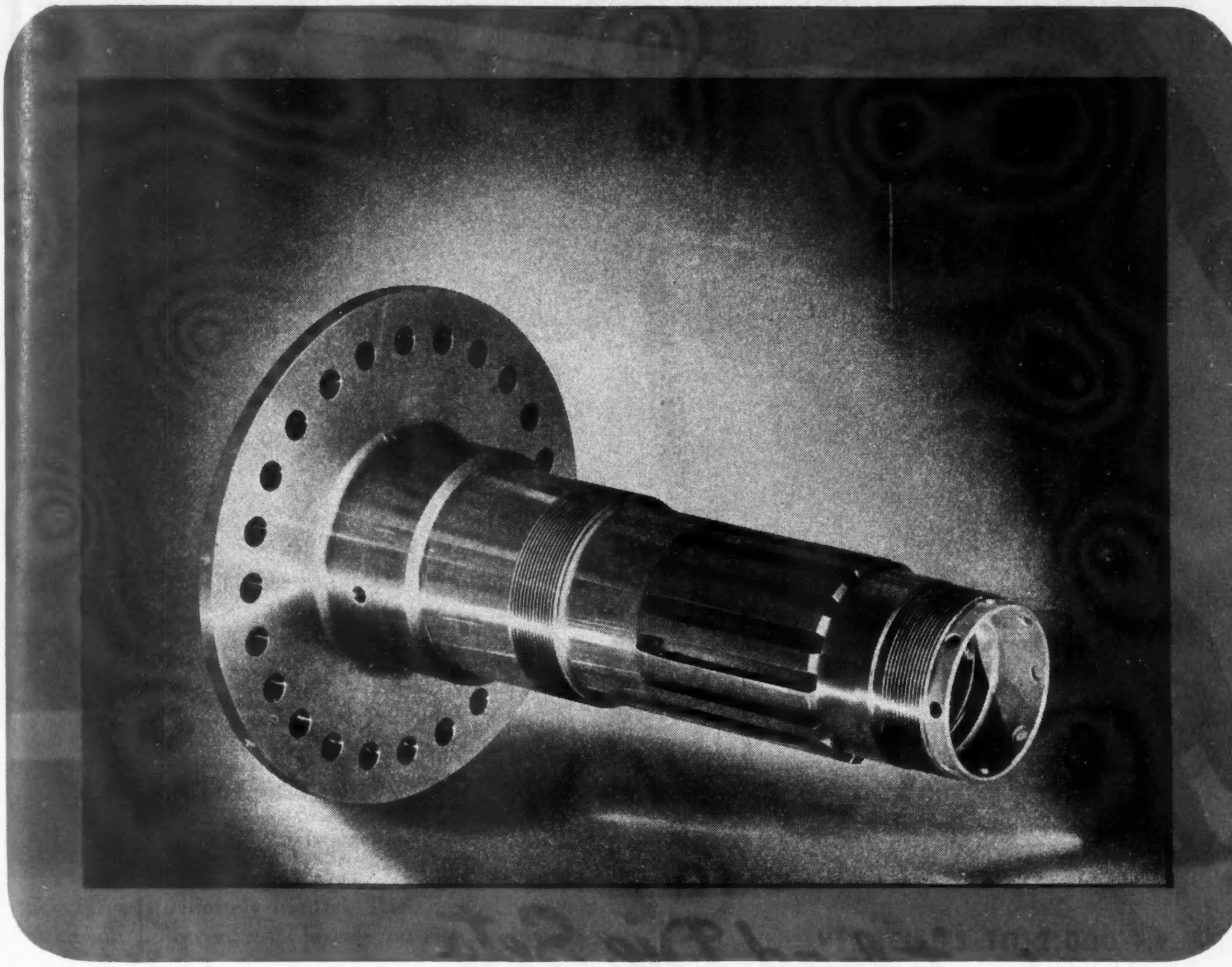
What are you doing to make sure that your product and your plant will be ready for tomorrow's competition?

Aetna can help you. Time spent in talking about futures—by your engineers and Aetna's—is time well invested. Let's do more than just think about it. A line or call to us makes the contact. Aetna Ball Bearing Manufacturing Company, 4600 Schubert Avenue, Chicago, Illinois.

In Detroit: Sam T. Keller, 7300 Woodward Avenue. Phone, Madison 8840-1-2-3.

MAKERS of
THRUST BALL BEARINGS, *Standard and Special . . .*
ANGULAR CONTACT BALL BEARINGS
ROLLER BEARINGS *. . . Special,*
BALL RETAINERS, HARDENED *and* **GROUND WASHERS**

Aetna BALL BEARINGS



$7 WORTH OF STEEL—AND A FLYER'S LIFE

Miles high in the sky, over enemy territory or a vast ocean, the life of an American flyer—the safety of a $75,000 fighting airplane—may depend upon this propeller shaft, or other equally vital plane or engine parts.

A lot of responsibility for the $7 worth of steel in the shaft.

Of course, the finished shaft is worth much more—for many man- and machine-hours have gone into its fabrication.

And that brings up a second responsibility of the steel—to the manufacturer.

Think how many dollars, how many man-hours would be lost—and schedules disrupted—if a hidden imperfection should suddenly show up to cause rejection at final inspection.

That's one reason for the use of Republic Electric Furnace Steels. They are added insurance against such losses—because they're as CLEAN and SOUND as the most expert furnace practice can make them.

Another reason is their *consistent* UNIFORMITY—their homogeneity. They do not vary in workability or hardenability—hence promote highest efficiency in mass production.

And they are "targeted" in the furnace to hit restricted specifications—accurately, repeatedly.

Republic offers you its unequalled experience and increased capacity to help you improve *your* products and reduce costs through the use of these fine steels.

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REPUBLIC
—Leader in the Production of
ELECTRIC FURNACE STEELS
"QUALITY" steels . . . alloy . . . stainless

They don't load Die Sets in BOMB BAYS

Die sets are work-a-day products that stay at home, holding and guiding the dies that stamp out and form plane parts by the millions. We can safely and proudly say that Danly Die Sets have speeded America's air program.

Danly facilities and service have been steadily increased since 1940. One of the major objectives was to be ready for the mass production of planes—that was sure to come—that came—planes that are blasting the way to winning the war.

If you need die sets in any phase of your production call Danly.

Call Danly:

CHICAGO	*Lawndale 7440*
MILWAUKEE	*Broadway 1644*
DETROIT	*Cherry 6666*
CLEVELAND	*Express 0300*
DAYTON	*Fulton 6651*
ROCHESTER	*Main 2554*
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DUCOMMUN METALS & SUPPLY CO.
Los Angeles . . . Kimball 0181

DANLY MACHINE SPECIALTIES, INC.
2100 South 52nd Avenue • Chicago, Illinois

DANLY DIE SETS

Welded Steel Fabrication

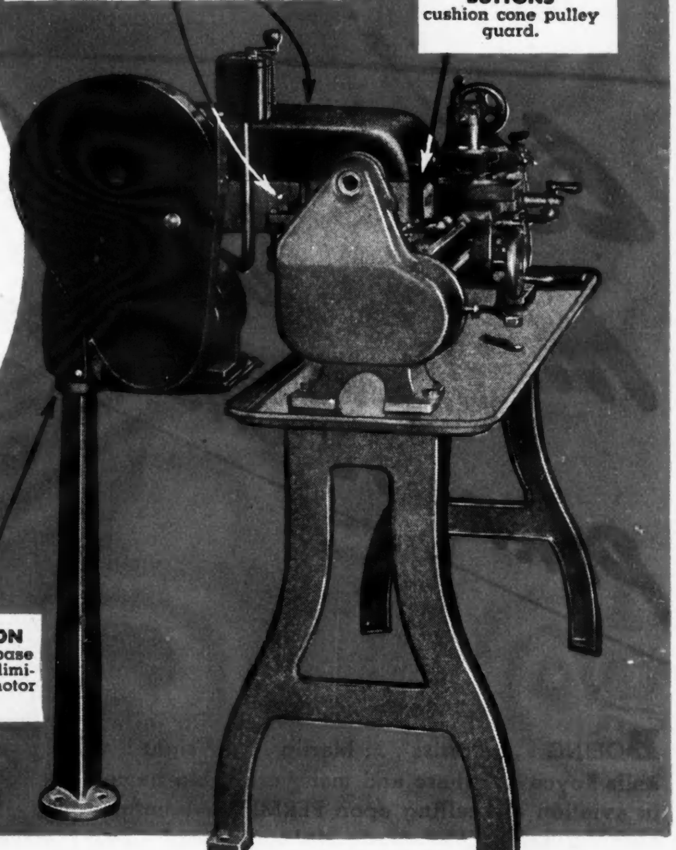
WE'RE TOO BUSY FOR WORDS

STOP ALL LEAKS

DETROIT GASKET & MFG. COMPANY

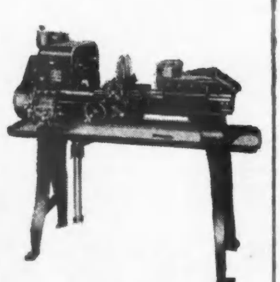
DETROIT 23, MICHIGAN

RUBBER CUSHIONED COUNTERSHAFT* and 3-POINT SUSPENSION



BRIEF SPECIFICATIONS

Swing over bed, 10½"... bed length, 43⅛"...spindle hole, 25/32"...capacity, ⅝" with push type collet...6-position automatic indexing turret... stroke of turret, 4¼"...12 spindle speeds from 30 to 1450 r.p.m.... moving parts protected by ball bearings or self-lubricating bronze bearings.



No. 840
Quick Change Gear Turret Lathe with automatic apron

motor vibration absorbed

In Logan Lathes the smooth operation essential to finely finished precision work is doubly assured... first, by rubber cushioning at vital points... second, by carrying the countershaft on a three-point suspension. To absorb the motor's vibration, to prevent its transfer to the lathe proper, the patented Logan countershaft is rubber cushioned at all three of its main supporting points... the pedestal red and the two hinge pins. In addition, the cone pulley guard, which covers both countershaft and headstock, rests on rubber buttons. *The entire Logan countershaft assembly is so designed that at no point is there a direct metal-to-metal contact between countershaft and headstock.* Furthermore, the three-point suspension steadies the whole countershaft assembly so that it cannot rock. This combination of rubber cushioning and three-point suspension is another example of the advanced design that assures sustained accuracy, safe operation, long life, and high-speed, low-cost production in all models of Logan Lathes. Write today for your copy of the latest Logan Catalog.

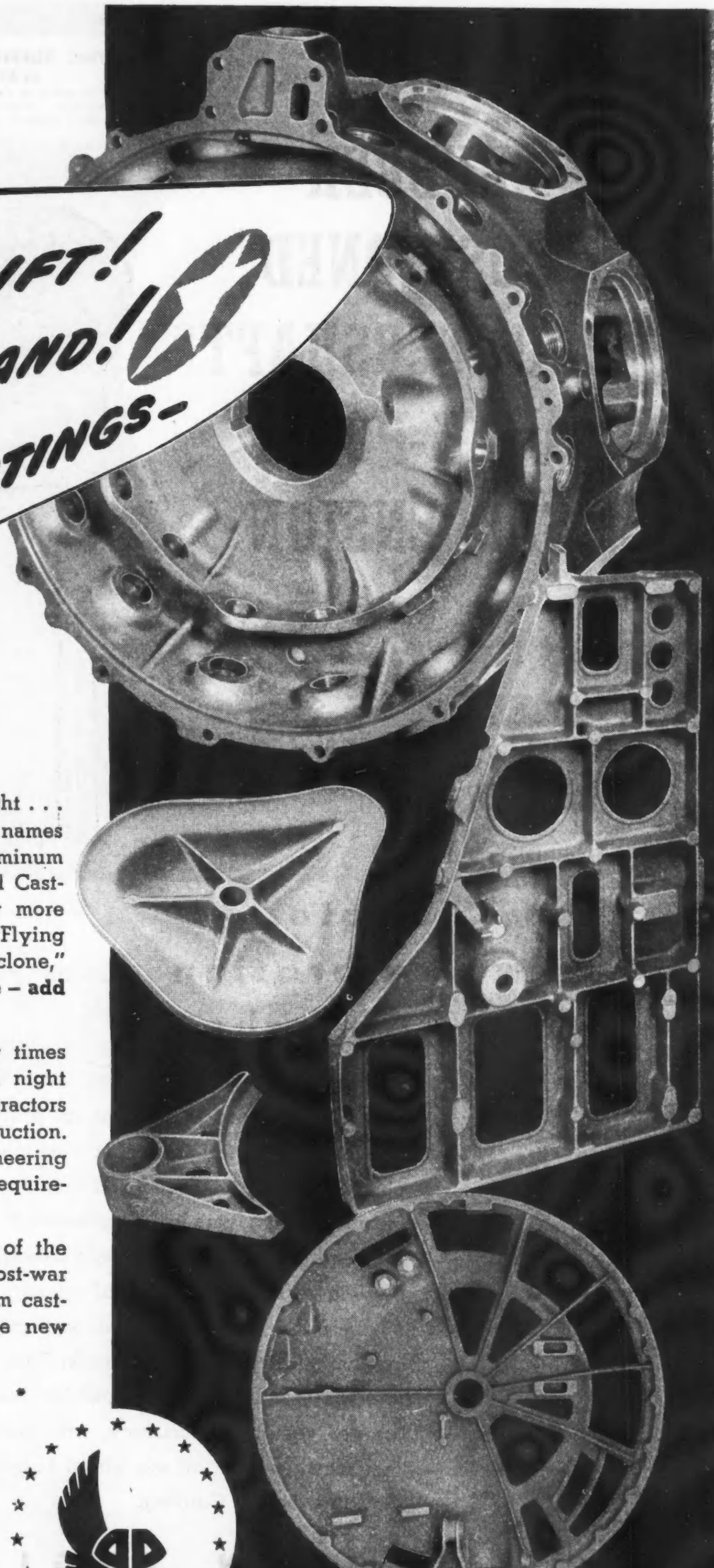
Logan

LOGAN ENGINEERING CO.
CHICAGO 30, ILLINOIS

A NAME TO REMEMBER WHEN YOU THINK OF LATHES

One of a series describing the finer features of Logan Lathes . . . Look for the next of the series

LESS TO LIFT! MORE TO LAND! WITH PERMITE CASTINGS—



BOEING . . . Curtiss . . . Martin . . . Wright . . . Rolls-Royce . . . these and many other big names in aviation are calling upon PERMITE Aluminum and Magnesium Permanent Mold and Sand Castings to help planes go farther and carry more bombs. Whether in the gun-turrets of a Flying Fortress or the crankcase of a Wright "Cyclone," the light metals **save** weight in the plane – **add** weight to the bomb-load.

With its production capacity many times multiplied, PERMITE is working day and night with aircraft manufacturers and their contractors in the drive for ever-increasing plane production. If your plant is a war producer, our engineering staff will be glad to discuss your casting requirements – with no obligation to you.

And, soon as the Axis is blasted out of the war, PERMITE will take its place in post-war production with Aluminum and Magnesium castings backed by the new knowledge – the new skill – that war experience has taught.

ALUMINUM INDUSTRIES, Inc.
Cincinnati, Ohio

***Detroit:* 902 New Center Building**
***Los Angeles:* 324 N. San Pedro St.**
***Chicago:* 616 So. Michigan Ave.**

PERMITE

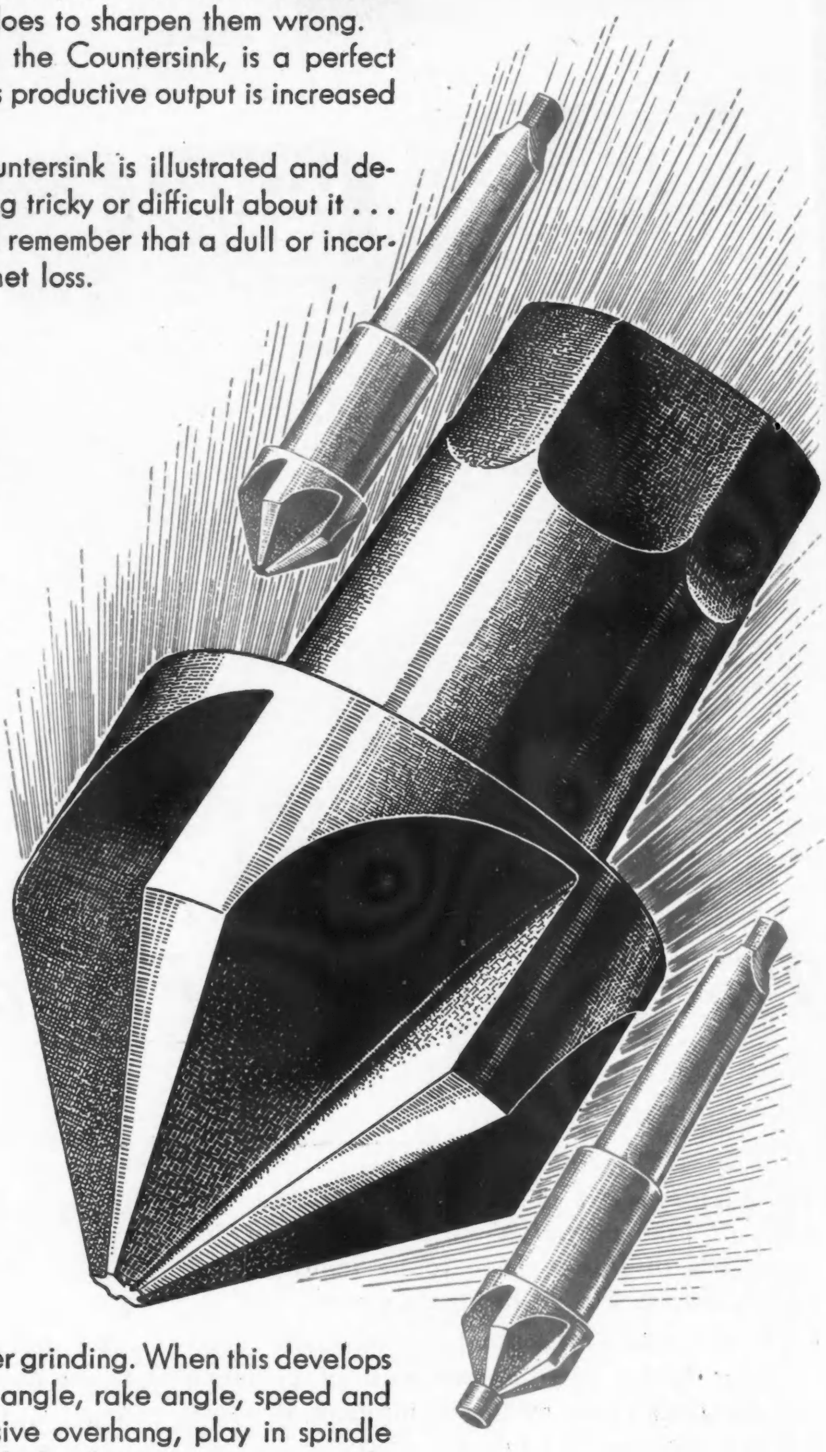
PERMITE ALUMINUM AND MAGNESIUM ALLOY CASTINGS

SHARP PRACTICE!

Good cutting tools deserve to be sharp . . . and it takes no more time to sharpen them right than it does to sharpen them wrong.

That universally used small tool, the Countersink, is a perfect example . . . **correctly** sharpened, its productive output is increased —its useful life extended.

The right way to sharpen a Countersink is illustrated and described on this page. There's nothing tricky or difficult about it . . . Simply read, study the diagram and remember that a dull or incorrectly sharpened Countersink is a net loss.



Regardless of the type of countersink (pilot or self-centering) its cutting edges are either ground cam relief or profile ground. Gairing countersinks are always furnished with ground cam relief flutes.

CAM RELIEF SHARPENING
1) Follow the original cam relief or
2) grind the face of the flute.

PROFILE SHARPENING
Always keep the angles as close as possible to the original flute design—Primary Land 3 degrees, Secondary Land 7 degrees.

Chatter may be caused by improper grinding. When this develops check insufficient end cutting edge angle, rake angle, speed and feed not in proper relation, excessive overhang, play in spindle bearing. For countersinking in tough, hard steel use countersinks with fewer flutes. Provide ample chip space in web.

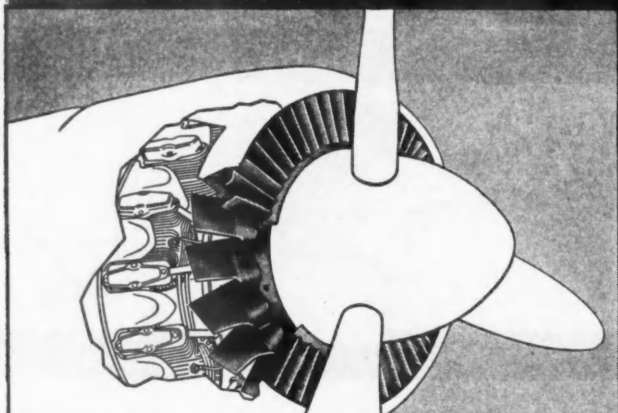
THE GAIRING TOOL COMPANY, Detroit 32, Michigan

Manufacturers of Standard, Special and Gair-Lock Inserted Blade Cutting Tools

GAIRING
FOR A QUARTER CENTURY SPECIALISTS IN FINE CUTTING TOOLS

Reprints on request for posting in your grinding department.

Cool 'em with FANS



DeBOTHEZAT LAMINAR FLOW PROFILE FAN with adjustable contravanes shown partially cut away and at minimum setting.

OUT OF OUR DeBothezat laboratories for aerodynamic research now comes a new type laminar flow profile steel fan wheel adaptable to air cooled aircraft engine cooling. Chief features would be to provide: ***adequate and controlled cooling at all air speeds with reduced cowl flap drag—and increased effective horsepower.***

This fan unit may consist of adjustable contravanes and a fan wheel mounted directly behind the propeller. The adjustable contravanes provide controlled cooling at varying flight conditions.

This new fan development is the product of the engineering staff that successfully solved the problem of blast-cooling radial air cooled aircraft engines which are virtually "buried" in U.S. tanks.

DeBothezat's modern aerodynamic laboratories are ably staffed with skilled technicians experienced in solving numerous difficult engine cooling problems.

De Bothezat Division of

American Machine and Metals, Inc.

East Moline, Illinois

Broaching

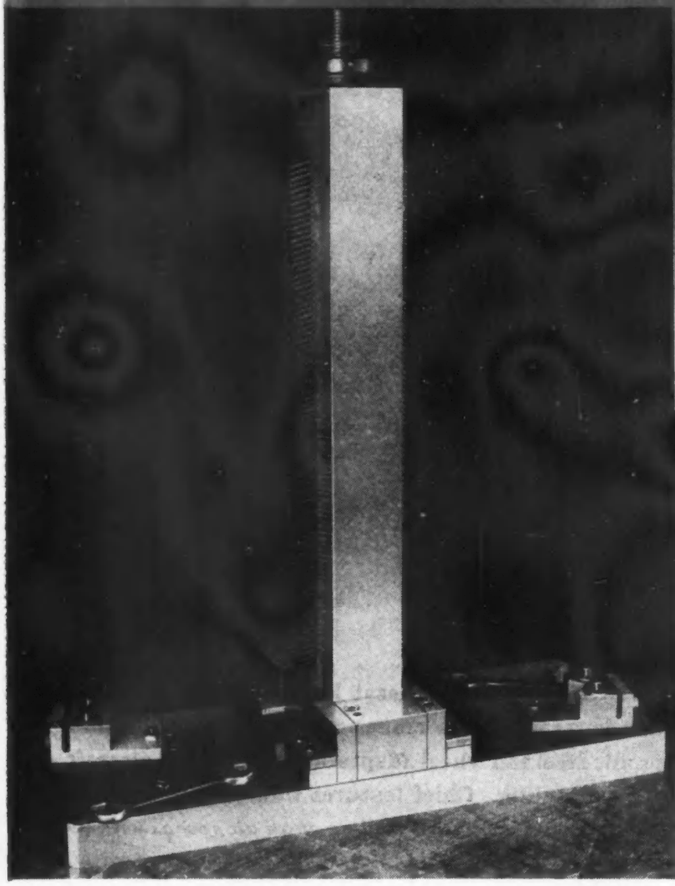
ON SHORT OR LONG RUNS

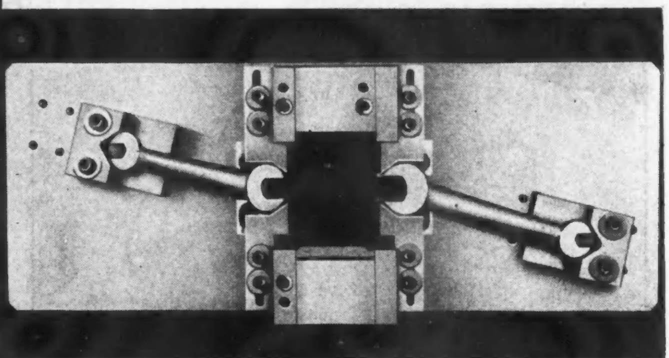
with

★ **Inexpensive tools**

★ **Simple fixtures**

★ **Use of existing equipment**





The photographs above show a Detroit Broach set-up for broaching the jaws of open end wrenches on a hydraulic press. No clamping is required and the locating blocks are adjustable to accommodate different wrenches. Broach inserts for different jaw sizes are easily interchangeable.

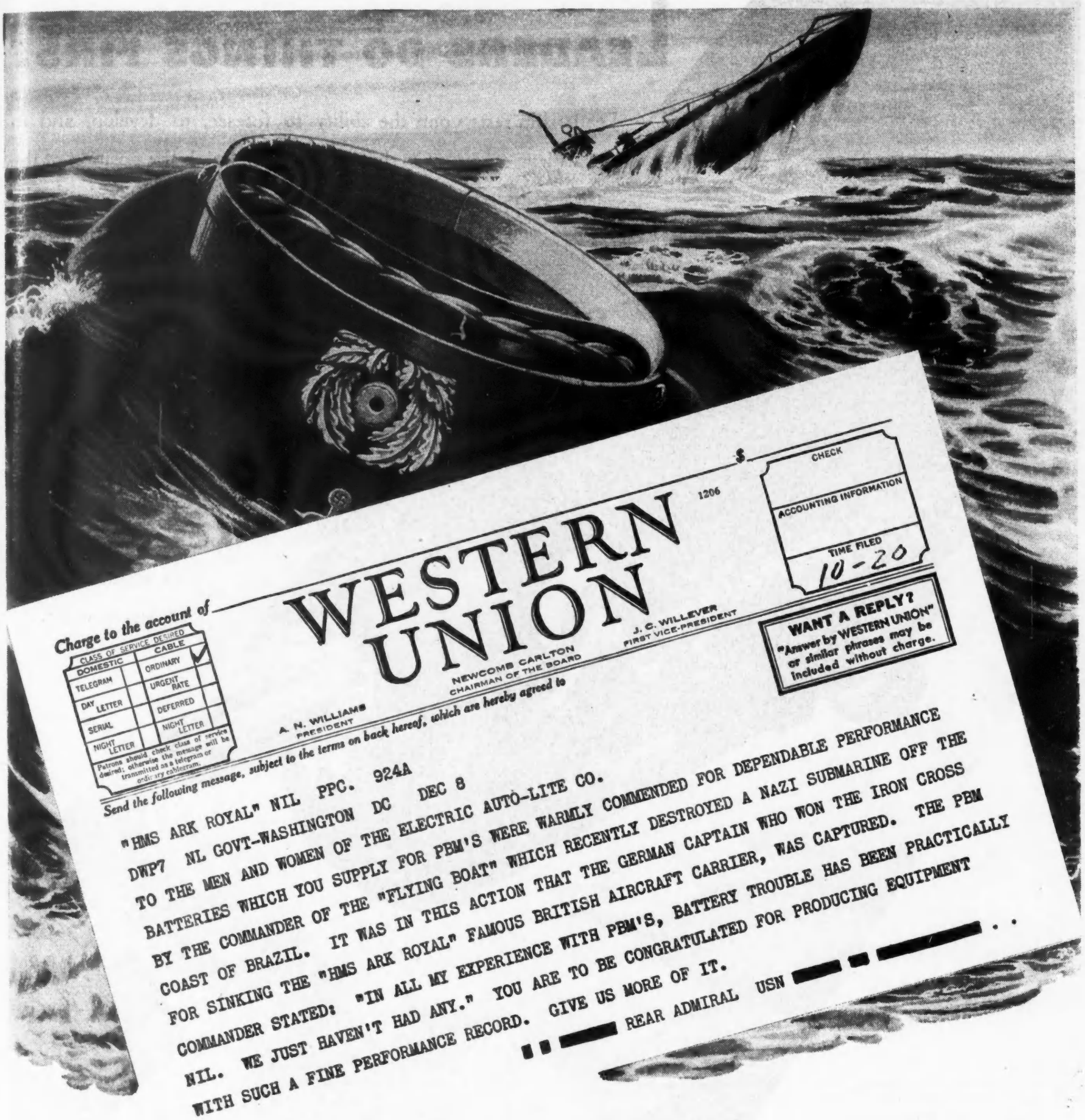
Although broaching was developed as a high production operation it can, through proper application, be used on small runs. Many jobs require only the simplest of tools and fixtures, such as those shown above. The work can be done on a simple hydraulic press such as is found in nearly every shop. Where different parts require similar operations it is often possible to provide the fixture with interchangeable pads so that several parts may be broached in the same general set-up.

There is a place for broaching in every shop. If you are looking for more speed, better finish, greater accuracy . . . and lower production costs . . . call on Detroit Broach Company. We will supply you with complete production and cost data without obligation.

ARMY E NAVY

DETROIT BROACH COMPANY

20201 SHERWOOD AVENUE • DETROIT, MICHIGAN
9308 SANTA MONICA BLVD. • BEVERLY HILLS, CALIFORNIA



The "Ark Royal" is avenged

The score of an "assist" in wiping out the submarine menace is typical of the service Auto-Lite units are rendering on battlefronts all over the world . . . From PBMs to jeeps, from combat wagons to crash boats, Auto-Lite is piling up a continuing record for "producing equipment with a fine performance record." . . . It is the unfailing performance of Auto-Lite units that makes the name internationally famous as the electrical equipment to use whenever dependability is a must. Important in establishing this enviable world-wide reputation is Auto-Lite's complete service so readily available everywhere.

THE ELECTRIC AUTO-LITE COMPANY
SARNIA, ONT. TOLEDO, 1, OHIO

TUNE IN "EVERYTHING FOR THE BOYS" STARRING RONALD COLMAN—EVERY TUESDAY NIGHT—NBC NETWORK

BUY WAR BONDS

AUTO-LITE


LEADERS DO THINGS FIRST
Leadership rests upon the ability to foresee, to develop, and to achieve—first. ★ On that critical basis, weigh the position of the Allison engine. ★ Allison built the first aircraft engine in the world to receive official military rating of more than 1,000 horsepower. ★ Allison manufactured the first airplane engine in all the world to weigh less than one pound per horsepower. ★ These are only two of the thirteen major technical advances in aircraft-powering credited to Allison. ★ Leadership is earned by achievements at the forefront of development.
Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR
NBC Network
LIQUID-COOLED AIRCRAFT ENGINES
Allison
DIVISION OF
GM
GENERAL MOTORS
KEEP AMERICA STRONG
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POWERED BY ALLISON:
P-38—Lightning • P-39—Airacobra • P-40—Warhawk • A-36 and P-51—Mustang

These steels are made by modern tool steel practice to Disston's high quality standards. Careful selection of materials, precise control and expert supervision result in an exceptionally sound and clean product.

ESTABLISHED 1840 TRADE MARK Reg. U. S. Pat. Off.

YOUR POSTWAR PLANS

most likely include the use of special steels. Disston metallurgists and engineers can put at your service an unusual background of experience with alloy and carbon steels to help you with your future program. No obligation. Write fully.

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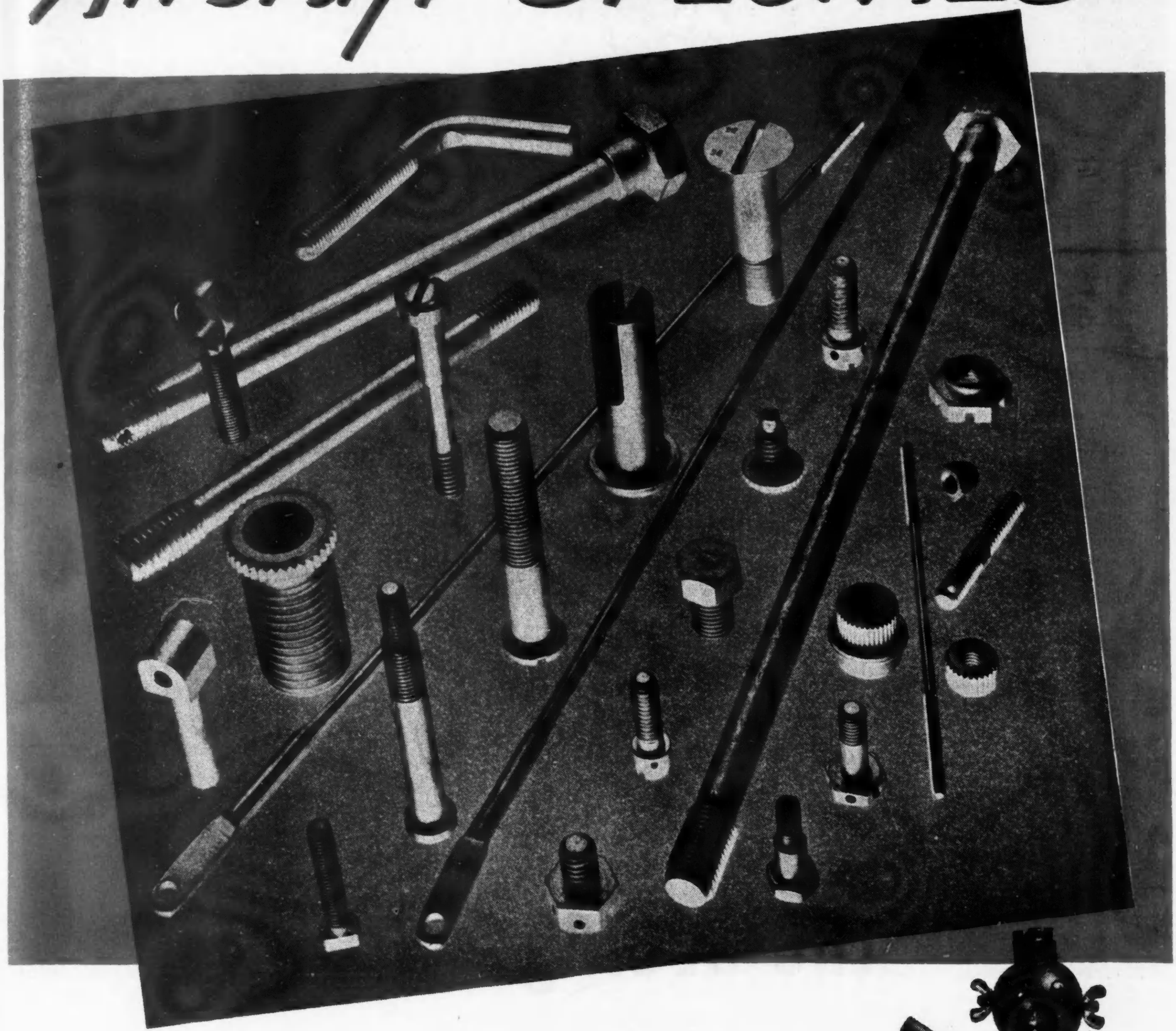
When the thermometer hits the bottom at 30,000 feet it's the extra degrees that Guiberson precision-built low loss heating equipment puts into the hearts of America's greatest bombers that helps keep fingers nimble and wits and minds alert to strike the Axis. Care and precision in manufacture are the heritage of every Guiberson-built aircraft part.




NOPAK builds both "Drives" and "Controls" for Air and Fluid Power
NOPAK Model B Cylinder with Center-line Mounting and built-in Self-Regulating Cushion.
Design engineers and production executives find that there is usually a happy combination of Standard Model NOPAK Valves and Cylinders which solves specific problems of application and control simultaneously. The need for specially designed units is largely eliminated. Valuable time is saved all along the way . . . from drafting room to assembly line!
By "teaming up" NOPAK Valves with NOPAK Cylinders, you can often solve two problems through a single source. At the same time, you insure high standards of performance in both drives and controls . . . performance that will prove a lasting credit to your product on the firing line of war production.
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GALLAND-HENNING MANUFACTURING CO.
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NOPAK VALVES and CYLINDERS
DESIGNED for AIR or HYDRAULIC SERVICE
NOPAK 2-, 3- and 4-Way Operating Valve for precision Control of Air or Hydraulic Cylinders.
New NOPAK Balanced Hy-Pressure Hydraulic Valve for "Finger Tip" Control of pressures up to 2000 P. S. I.
NOPAK Foot Operated Control Valves available in 3 different cycles of operation.
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NOPAK Heavy Duty Steel Tubing Cylinders have welded flange construction, eliminating tie-rods.

A 3718-1P-R2

LIFE BLOOD

for Aircraft Controls

Several important types of Whiz Hydraulic Fluids are manufactured by R. M. Hollingshead Corporation, a major supplier for Army and Navy Aircraft.

Of these fluids, two types are currently in great demand. Both conform fully to Government specifications. Each is supplied in two grades.

TYPE AND GRADES	INDICATED USES	CHARACTERISTICS
Whiz Castor Oil Base Type Grade C—Light Grade A—Heavy	Used primarily in hydraulic braking systems, shock absorbers, strut shocks, retractable landing gears. Other mechanisms where specified.	Non-gumming; provides maximum lubrication and correct viscosity. Maintains stable fluidity. Grade C for sub-zero temperatures. Grade A for warmer climates.
Whiz Petroleum Base Type Grade L—Light Grade M—Medium	For use in automatic pilots. Other mechanisms where specified.	Non-gumming. Non-corrosive—will not damage metal, synthetic or natural rubber parts. Maintains stable fluidity. Grade L for temperatures down to −60°F.: will not thicken, congeal, or freeze. Grade M designed for use at temperatures of −50°F. and higher.

Your inquiries about these hydraulic fluids will receive prompt attention. Our engineers will gladly work directly with your engineers in designing special chemical products to meet unusual requirements. *R. M. Hollingshead Corp., Aviation Products Division, Camden, N. J.; Toronto, Canada.*

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LEADER IN
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ALSO MAKERS OF WHIZ RUST PREVENTIVE COMPOUNDS, COMPOUNDED LUBRICANTS, LUBRICATING OILS, AND CLEANING COMPOUNDS FOR AIRCRAFT

Whiz

The battle against the subs is NOT over. Sure, the record of our fight against them is a gallant one. But the end is not yet. We are building more steam and diesel engines than ever. Turning out cannon and war-making machinery that, in time, will silence the enemy. Meantime, Americans—keep that guard up!

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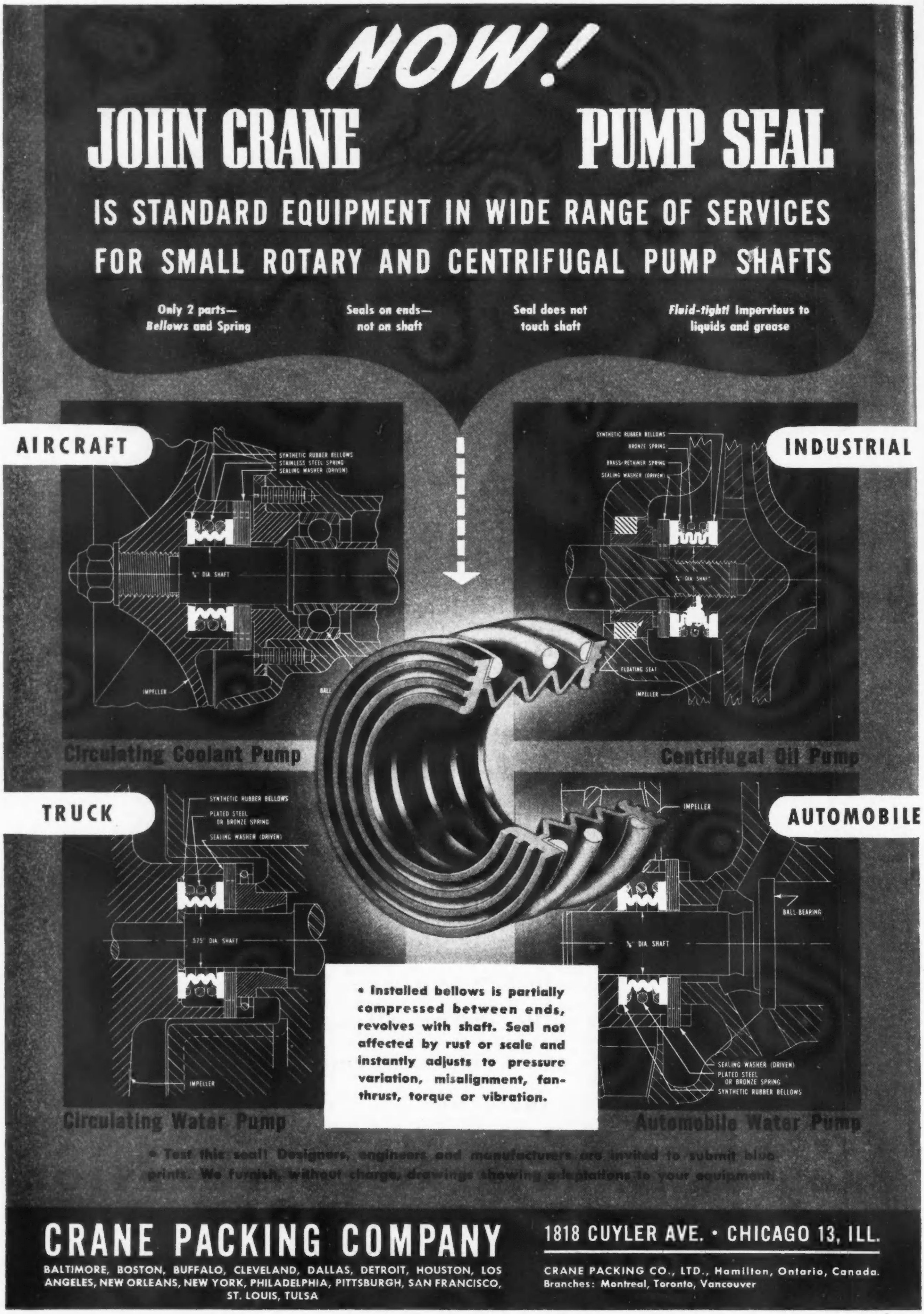

NOW!
JOHN CRANE PUMP SEAL
IS STANDARD EQUIPMENT IN WIDE RANGE OF SERVICES FOR SMALL ROTARY AND CENTRIFUGAL PUMP SHAFTS
Only 2 parts— Bellows and Spring
Seals on ends— not on shaft
Seal does not touch shaft
Fluid-tight! Impervious to liquids and grease
AIRCRAFT
SYNTHETIC RUBBER BELLOWS
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SEALING WASHER (DRIVEN)
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BALL
Circulating Coolant Pump
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Automobile Water Pump
• Installed bellows is partially compressed between ends, revolves with shaft. Seal not affected by rust or scale and instantly adjusts to pressure variation, misalignment, fan-thrust, torque or vibration.
• Test this seal! Designers, engineers and manufacturers are invited to submit blue prints. We furnish, without charge, drawings showing adaptations to your equipment.
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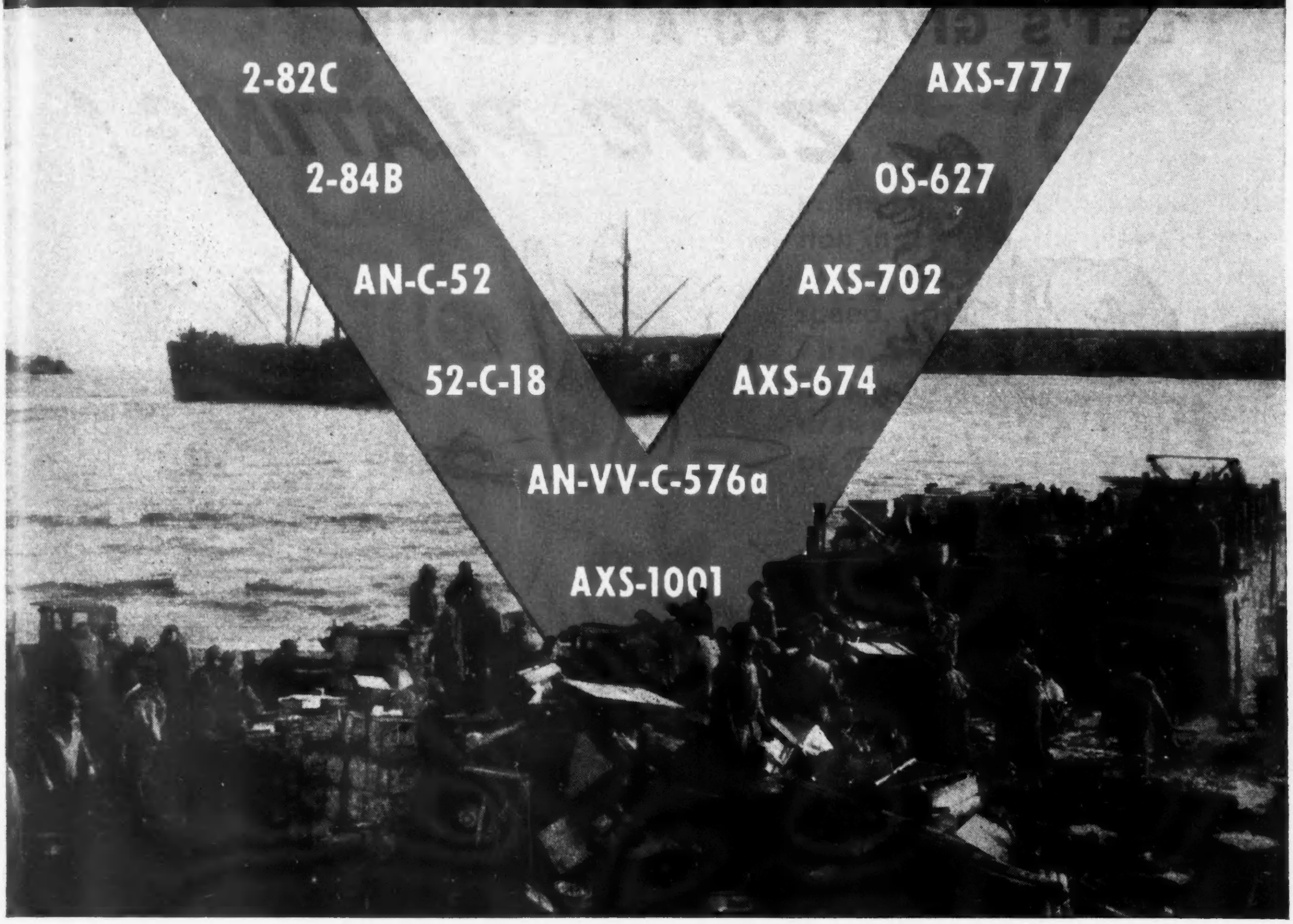
"SPECS" THAT SPELL PROTECTION



Everyone concerned with packaging of metals knows what the above symbols mean.

They are government specifications for protection of metal parts and equipment, such as you see piled in the foreground of this landing view. All over the world our armed forces are putting into action the products that industry has made so well and so fast during these frenzied war production years.

Will the contents of these packages be preserved, ready for immediate use when opened after long storage in damp climates? Uncle Sam says they must be, and has set up many "specs" as standards for packaging. The best known ones, for which there is most demand, are listed above.

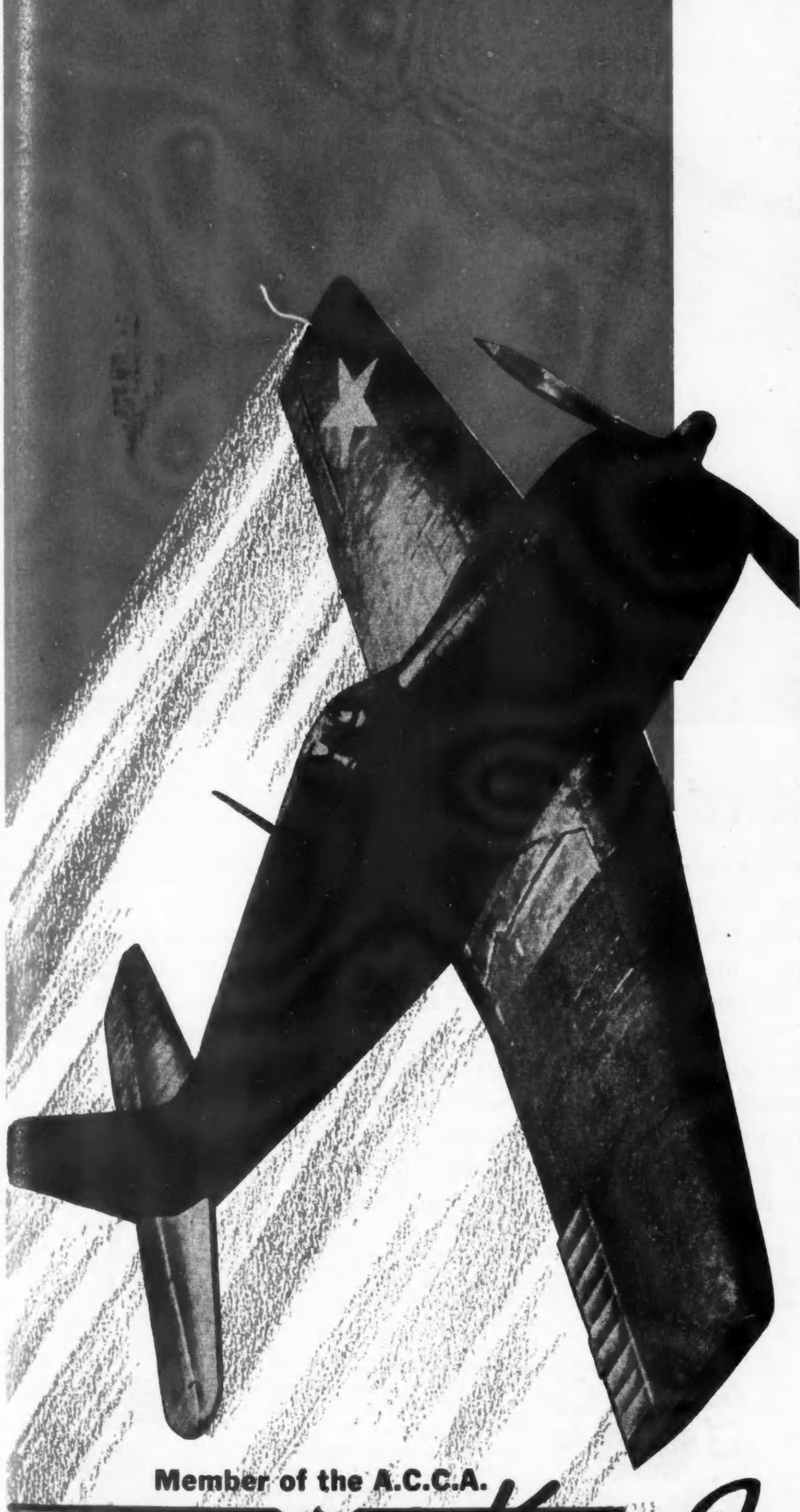
E. F. Houghton & Co. supplies approved products to meet each one of those important specifications.

Ask the Houghton Man, or write direct for full information. And remember, please, that a concern making specialized oils and greases for 79 years has the edge when it comes to "beating," not merely meeting, today's crucial rust preventive requirements.

E. F. HOUGHTON & CO.
PHILADELPHIA
Sales and Service in all principal cities

Houghton's RUST *Preventives*

The HELLCAT Delivered "More Climb and More Speed"



In the early days of our participation in the war, the Navy urgently demanded more climb and more speed. The Hellcat is the answer. This sturdy, well armed and armored fighter is built from plans drawn entirely from the experience of the present war.

Combining super-speed and maneuverability with superlative fighting power and ruggedness is the accomplishment of American designing genius. Supplemented by the broader use of drop forgings for parts which must withstand terrific stresses, these rugged planes are credited with a 10 to 1 ratio over the enemy.

There are so many parts on today's fighting planes for which only the inherent strength of forgings is adequate that the demand for forged parts grew in excess of increased aircraft production.

To meet this demand, the capacious plant of the Kropp Forge Aviation Company is working in endless shifts, turning out tremendous quantities of air-frame drop forgings exclusively. Can we aid you in improving your production?

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Kropp Forge Aviation Co.

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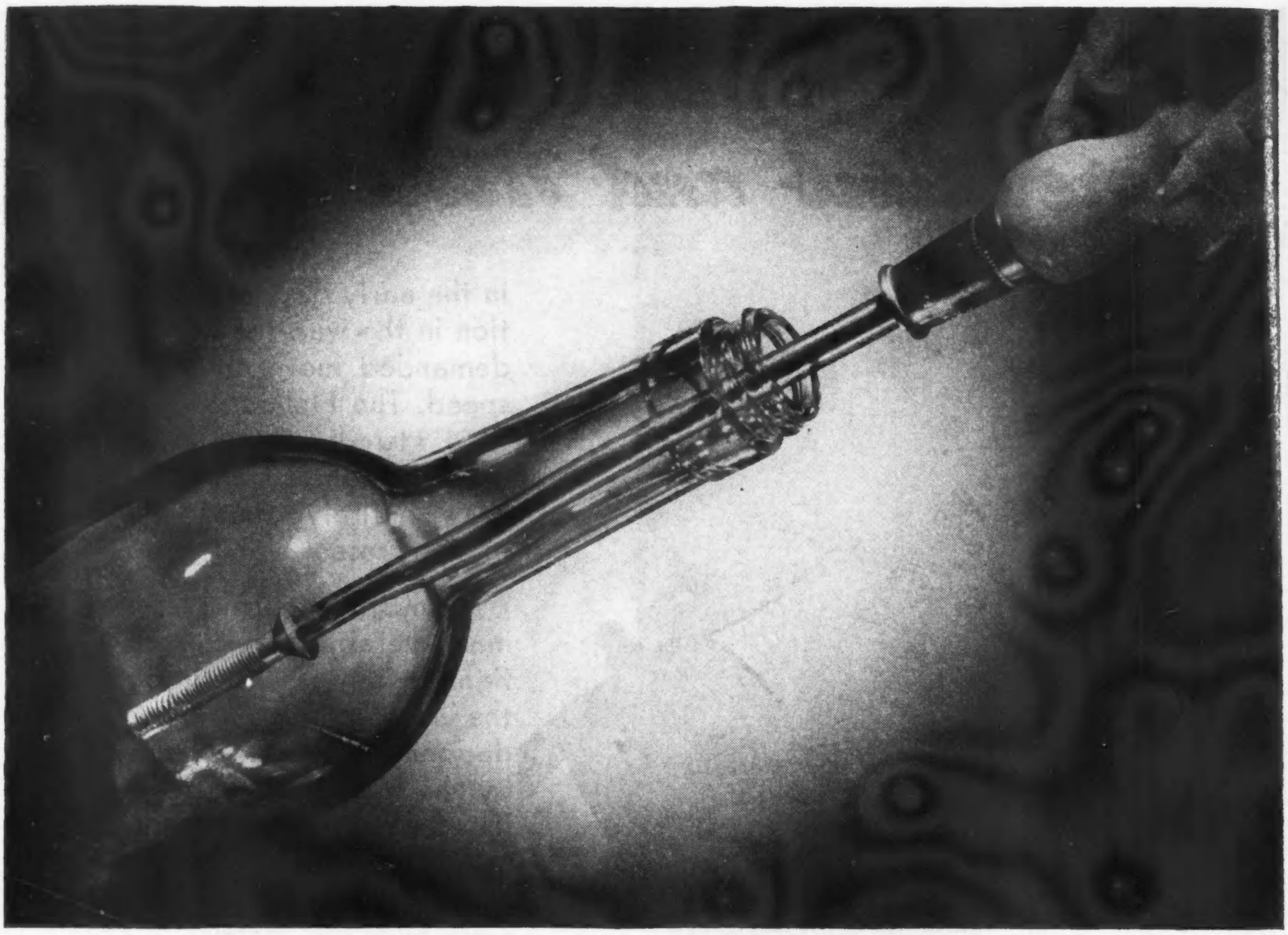


"Break that Bottleneck!"

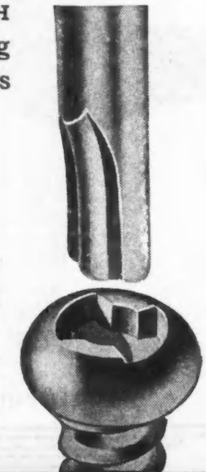
Eliminate the slow-down of fumbling around hard-to-get-at spots on assemblies. Here is where the CLUTCH HEAD Lock-On feature, uniting screw and bit as a unit, substitutes seconds for minutes . . . reduces haphazard groping to a speedy, simple, and certain operation by permitting one-handed reaching and driving from any angle. This frictional lock is instantly obtained with a reverse turn of the Assembler's Bit in the recess of the CLUTCH HEAD Screw. The hold is definite; yet it is automatically released when the screw is turned for the drive home. So, too, in field maintenance, this CLUTCH HEAD Lock-On feature bypasses the bottlenecks to save time by simplifying repair and adjustment operations. With a Center Pivot hand driver, service men find it easy to *withdraw and save* CLUTCH HEAD Screws for re-use, undamaged and held securely against dropping and loss. Similarly, the long reach through the bottleneck frequently saves the dis-assembling of surrounding units for access to points beyond.

Would you care to personally inspect and test the many exclusive advantages of CLUTCH HEAD Screws? Then let us send you package assortment along with sample Center Pivot Bit and fully illustrated Brochure.

This is the only modern screw operative with Assembler's Bit or ordinary type screwdriver. It is available in Standard and Thread-forming types for every purpose... with features that contribute definitely to smoother and lower cost assembly line operation.

CLUTCH HEAD SCREWS

Note the economy of this rugged Center Pivot Assembler's Bit. It delivers a longer uninterrupted spell in operation and requires only a brief application of the end surface to a grinding wheel to restore its original efficiency.



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CHICAGO CLEVELAND NEW YORK

"American Evaluates Pound Saved on a Plane at $600.00"

SAYS CHARLES A. RHEINSTROM,
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"The necessity for exercising the strictest control over a plane's empty weight is constantly being brought home to the manufacturer by the airlines. Pounds saved on military planes, of course, mean additional speed, range, armor, firepower—factors which cannot be evaluated in money. In commercial aviation, however, a lifetime price tag can be attached to reduced weight. It is estimated at American Airlines that the figure on that price tag amounts to $600.00 during the first five years of the life of a plane for each pound saved."

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- Approved by all government aviation agencies.
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- "Outlast the plane."

ANCHOR NUT—WING STYLE

This is one type of the famous Boots All-Metal Self-Locking Nuts

BOOTS SELF-LOCKING NUTS

"They Fly With Their Boots On—Lighter"

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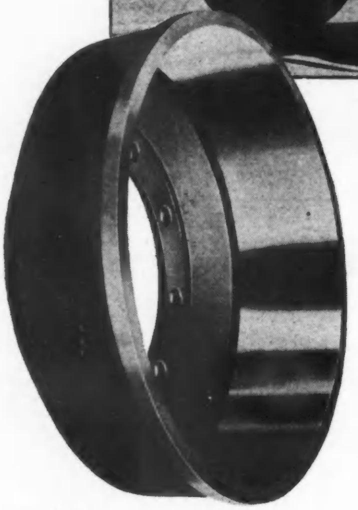
BRILLION BRAKE DRUMS *made to Specifications* CAN TAKE IT!

Kenworth Dump Trucks, Manufactured by the Kenworth Motor Truck Corporation, Seattle, Washington



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BRILLION Brake Drums are made to meet a specific need—made to meet the manufacturer's specifications—that's why! Brillion Brake Drums are cast high tensile strength gray iron, the finest that foundry skill and experience can manufacture. *We are brake drum specialists.* With us brake drums are a major item—*not* a side line. Today, thousands of Brillion Brake Drums are in use on trucks, like the one shown here, and fighting equipment used all over the world. And, all brake drums made to meet the manufacturer's specifications! Tell us your requirements and we will furnish you quotations.

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***Send us* YOUR SPECIFICATION *for* BRAKE DRUMS**

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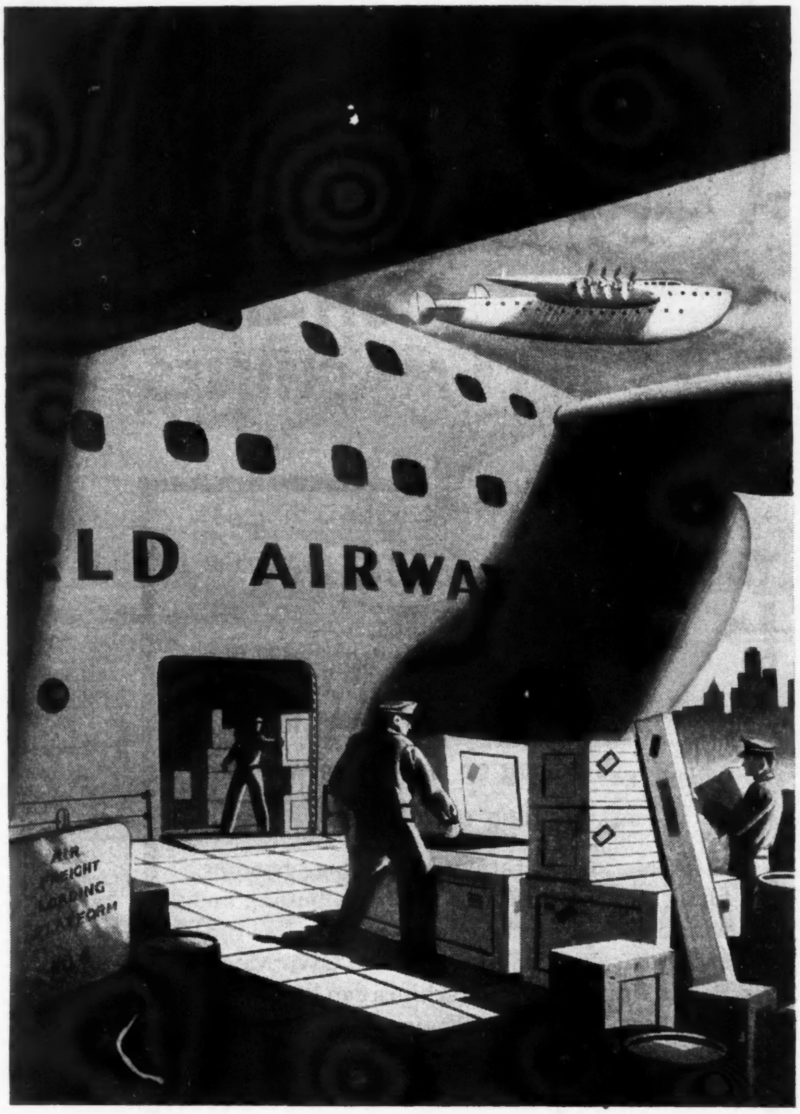

.. DURING THE LIFE OF A STAINLESS STEEL PLANE

THOUSANDS of extra hours of cargo-carrying life are expected from the new cargo planes being built of stainless steel.

Stainless steel contributes to these extra hours because it has a fatigue strength superior to that of other materials used in plane construction. According to aeronautical designers, this superior fatigue strength should substantially increase the life of a cargo plane made of stainless steel.

Furthermore the corrosion resistance of stainless steel is so great that its use for structural parts entirely eliminates the necessity for protective coatings. The permanently smooth, polished finish of stainless steel needs no protection. Air friction on the bare surface is less and this holds surface drag to a minimum.

Another advantage to the aircraft industry lies in the ease with which stainless steel can be formed—by rolling, drawing or stamping, and the other usual methods of fabrication. The range of methods by which stainless steel can be welded means quicker, cheaper assembly, and a smooth, streamlined surface.

We do not make stainless steel, but we do make ferro-chromium — the backbone of stainless steel. For more than 35 years our metallurgists have studied ferro-alloys and alloy steels in the laboratory and in the field. If you have a question on the selection or use of stainless steel, consult us.

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In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

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Uncle Sam's warships are seeing plenty of action these days. That means inescapable battle damage to essential electrical equipment aboard ship.

"Shell Shocked" Motors

GET WELL FAST!

To help put such equipment back in fighting shape *fast* is the wartime job of many Westinghouse District *Manufacturing and Repair** Plants.

Motor casualties are rushed direct from the ships to these plants—located near Navy repair yards.

Damaged parts are replaced, the entire motor and control reconditioned, using the latest approved methods and materials. Then they're returned to the Navy to be put back on duty.

This emergency service is typical of many that Westinghouse M & R Plants are rendering today—a type of service that's available to all wartime industry.

Every Westinghouse M & R Plant is part of a nationwide service organization—with local branches as close as your telephone. Factory trained men, using factory methods and equipment, are ready to give you complete, dependable repair service on any type of electrical equipment.

J-90500

When vital electrical equipment needs repair... phone the nearest office of Westinghouse Electric and Manufacturing Company for

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PLANTS IN 25 CITIES... OFFICES EVERYWHERE

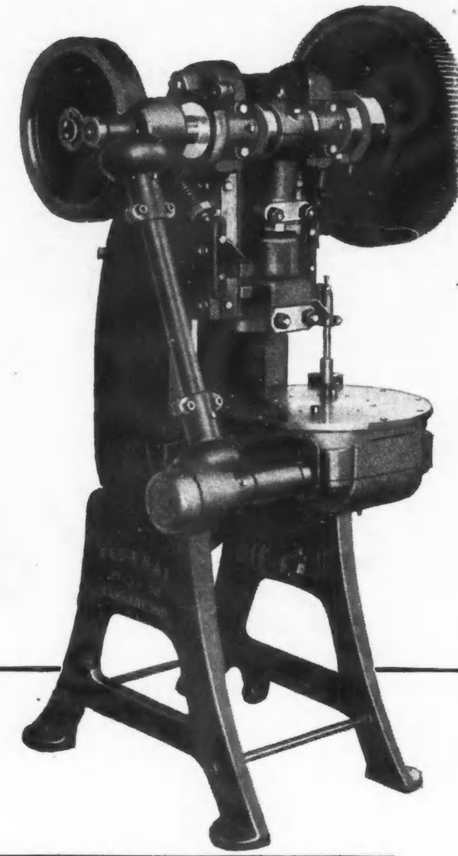
COMPLETE REPAIR SERVICE

*33 M & R PLANTS • • ONE NEAR YOU

FEDERAL PRESSES

SAVE MANPOWER

—Time and Money, Too!



Federal Dial Feed Presses are now being used for hundreds of time-saving, work-saving, money-saving operations in factories throughout the country—for their versatility is limited only by the tooling skill and resourcefulness of the production engineers. Federal Dials are easily indexed to any part of the crankshaft revolution, from 90 to 180 degrees, giving long or short dwell of the dial. Positive-locking mechanism smooths out the dial action, permitting unusually high speeds with exceptional accuracy, and assuring additional safety for the operator. Cannot skip or coast by stations. And on some jobs the dial feeds can be equipped with automatic loading and ejector mechanisms which often increase production speed as much as 4 to 5 times over hand operations. Available in eight sizes. *Write today for new catalog* which illustrates and describes the complete line of Federal Presses.

FOR MANY JOBS

- **Burnishing**
- **Staking**
- **Broaching**
- **Marking**
- **Forming**
- **Assembling**
- **Combinations**

THE FEDERAL PRESS CO.

503 Division Street, Elkhart, Indiana

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ORDER NOW FOR WAR AND POST-WAR PRODUCTION

Federal Presses will be just as effective in overcoming tomorrow's peace-time production problems as they are in today's war production. It will pay you to order now, for today's needs or prompt post-war delivery.

Below—Rotary switches are speeded to completion at P. R. Mallory and Co., with help of Federal Dial Feed Presses.

FEDERAL DIAL FEED PRESSES

RUBBER SHATTERS LIKE GLASS

OIL CONGEALS,
GASOLINE FREEZES

100 DEGREES BELOW ZERO!

Going down! Zero . . . 10 below . . . 50 below . . . 100 below . . . and still going! Not in a scientist's laboratory, but in everyday life . . . in industry.

Far-below-zero temperatures have been put to work. Machine parts are shrink-fitted together by the application of extreme cold to one of the parts. Methods of marketing food are being changed by new high-speed freezing processes.

Refrigerated test chambers are teaching men and airplanes how to fly in those strange and frigid atmospheres . . . the troposphere and the true stratosphere.

Today sub-zero temperatures . . . produced by General Electric Industrial Refrigeration and Air Conditioning equipment, are working in hundreds of ways to help speed up America's war effort . . . to help machines work more efficiently.

Tomorrow, when war clouds lift, these new techniques will bring benefits to all in flexible, efficient air conditioning and commercial refrigeration equipment . . . from General Electric.

General Electric Co., Air Conditioning and Commercial Refrigeration Divisions, Section 442, Bloomfield, New Jersey.

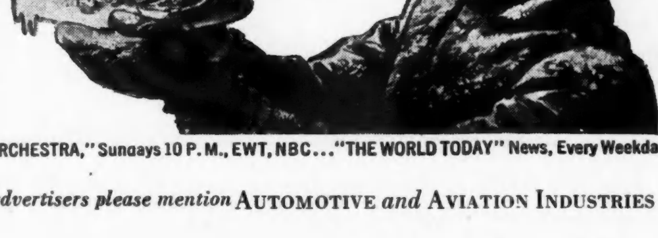
☆ BUY WAR BONDS ☆

METALS SHRINK
WATCHES STOP

Industrial Refrigeration by

GENERAL ELECTRIC

FOOD FREEZES
INSTANTLY



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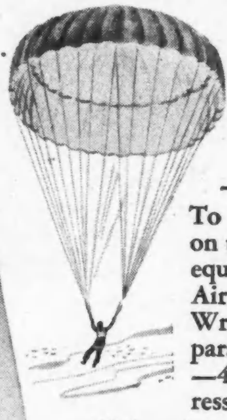
BAILING OUT FROM 8 MILES UP

—WHAT IT TAKES TO MAKE A RECORD PARACHUTE JUMP FROM 40,200 FEET ALTITUDE

This is what the well-dressed U. S. Army flier wears when he decides to bail out from 40,200 feet. Before climbing to this extreme altitude in a Boeing Flying Fortress, the test jumper wore regulation underclothes, trousers and blouse; an outer suit of gabardine and under it processed "chicken feather" suit for extra warmth; helmet and goggles, two pairs of gloves — one of silk, next to the hands — and another of leather.

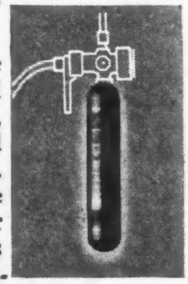


Now that planes get up to 30,000 and 40,000 feet, airmen face the possibility of having to jump from altitudes as high as 8 miles up. Reaching the ground safely from the stratosphere presents many special problems —one of the most important is breathing.

To ascertain the effect of extreme altitude on the body, and to test emergency bail-out equipment, an officer of the U. S. Army Air Forces' Aero Medical Laboratories at Wright Field, recently made the highest parachute jump ever performed in America —40,200 feet from a Boeing Flying Fortress. The descent took 23 min. 51 sec.

"I found out just exactly what I wanted," he said. "Now, we can say to the men, 'Okay, if you do have to get out, you can do it.'"

When flying in the "thin" air of high altitudes, aviators must be equipped with oxygen masks. Oxygen cylinders aboard the plane provide the source of supply, but if it becomes necessary to "bail out," the flyer must carry his oxygen with him.



The officer carried this reserve supply of oxygen in two metal bottles or bail-out cylinders, under high pressure, each good for about 20 minutes' supply. They are zippered into the thigh pockets in the outer flying suit. One bottle is connected by tube to an oral-nasal mask; the other is fed into a tube only, to be put into the mouth if the mask should fail to function, or the oxygen in the mask bottle should be exhausted. Before jumping, or in the event the plane oxygen supply is disrupted, the aviator turns a valve on the bail-out cylinder and breathes from this reserve supply of oxygen.

Metal oxygen bottles or bail-out cylinders are manufactured from Globe Seamless Steel Tubing. These cylinders are subjected to exacting metallurgical and ballistic tests. Globe ability to produce steel tubes of exacting characteristics is helping to make equipment of vital importance to our armed forces of the air.

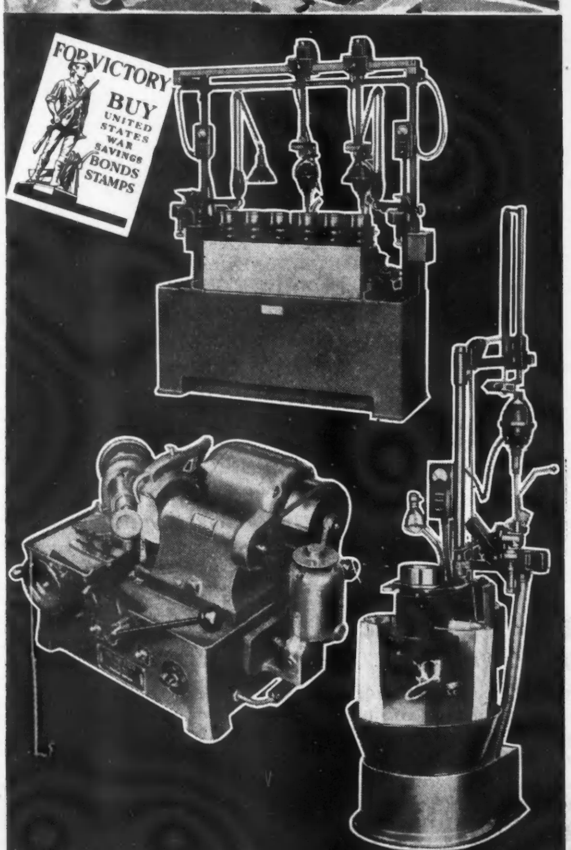
GLOBE TUBES

★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES
★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

5009

GLOBE STEEL TUBES CO., *Milwaukee 4, Wis., U. S. A.*

MORE HOURS WITHOUT SERVICING
FEWER HOURS OUT FOR SERVICING



Perhaps that's a big reason for the success of allied bombing of enemy cities and installations. At any rate the speed and precision of HALL equipment keeps plane performance at peak efficiency more hours without needed service, — out of service fewer hours for servicing. Because HALL Valve Servicing Equipment exactly duplicates (in a hurry anywhere) the precision and finish obtained by the engine manufacturers in their production, it has been widely adopted wherever airplane engines must be serviced. If YOU have a valve problem, write us today for complete information on how HALL equipment can solve it.

THE HALL MANUFACTURING COMPANY, TOLEDO 7, OHIO

HALL

Not All "Water Logging" Happens In Water

A LOG can absorb enough water to lose buoyancy and sink. Even though none of the materials you use look like logs, many of them may absorb weight just as readily, and much more rapidly.

Take for example, oil seals, hose, packing, gaskets, grommets, diaphragms, and all other resilient parts. When used in the presence of oil, these may act just like a log by absorbing weight not included in original design calculations.

Dead weight caused by the oil-absorption of thousands of such resilient parts in a single plane may "sink" the performance of the ship.

But Hycar synthetic rubber with its light weight, and its superb resistance to oil to keep it light, gives protection against increased dead weight not offered by any other comparable material. Hycar is 15% to 25% lighter than many other synthetics, and retains this important quality throughout its long life.

Oil-swell can be closely controlled with Hycar to insure dimensional stability. And Hycar has an operating range of −65° to +250° F. and abrasion resistance 50% better than natural rubber. Unlike many other oil-resistant synthetic rubbers, Hycar has a minimum tendency to cold flow after taking the initial deformation, even at elevated temperatures.

These are qualities you need in resilient materials used in the presence of oil. Let our technical service staff help solve your individual problems. *Hycar Chemical Company, Akron 8, Ohio.*

Hycar

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubber

War Patterns In Silver

NO LONGER is the use of silver as a raw material confined largely to the coinage mints and manufacturing jewelers. Silver has its War patterns, too—and you will find them hard at work, principally in airplane engine bearings. "Precious metal" is an understatement in describing silver's value in aviation engine performance.

Two short years ago, silver was a negligible factor in aviation manufacture. But when War stresses and demands created problems that other metals could not solve, silver stepped into the breach.

Through techniques such as the Mallosil Process developed by Mallory, new methods of bonding silver with base metals have increased reliable engine performance tremendously. The Mallosil* Process permits large scale production of precision Mallory Bearings to give longer wear and to meet the brutal stresses and strains that fighter and bomber engines must undergo on every flight.

Today, approaching 25% of the World's silver output goes into the engine bearings that insure the warplane's incredible records. Almost every high output warplane engine relies on silver bearings for all engine, reduction gear and supercharger bearings.

Mallory has pioneered the new silverizing methods so well that makers of warplane and other heavy duty bearings now depend on Mallory as a reliable source for precision production. Mallory facilities, expanded over and over again to meet military aviation needs, are recognized as the most advanced in the new techniques which have raised aircraft engine performance to so much higher levels.

Commercial aviation will benefit from this War development. But the scope of silverized bearings does not stop with aviation. In plant and factory, on the road—wherever precision bearings are essential for improved engine performance, Mallory Bearings have much to offer to the plans of design engineers.

War production occupies our stage today. But we are looking to the future and will be glad to discuss bearing problems and applications for peacetime designs. Get in touch with us.

P. R. MALLORY & CO., Inc.
INDIANAPOLIS 6 INDIANA

P. R. MALLORY & CO. INC.
MALLORY SERVES THE AERONAUTICAL, AUTOMOTIVE, ELECTRICAL, GEOPHYSICAL, RADIO AND INDUSTRIAL FIELDS WITH . . . RESISTANCE WELDING ELECTRODES NON-FERROUS ALLOYS, POWDER METALLURGY AND BI-METALS . . . ELECTRICAL CONTACTS, . . . THE MALLOSIL* PROCESS—BEARINGS . . . SPECIALIZED PRECISION ELECTRONIC PRODUCTS

*Reg. U. S. Pat. Off.

"... This is your nation's tribute to your patriotism and to your great work in backing up our soldiers on the fighting front."

Under Secretary of War

Serving the Armed Forces

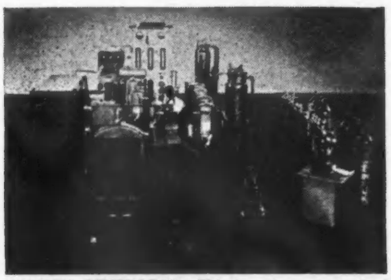
MOBILE OXYGEN GENERATOR

MOBILE HYDROGEN GENERATOR

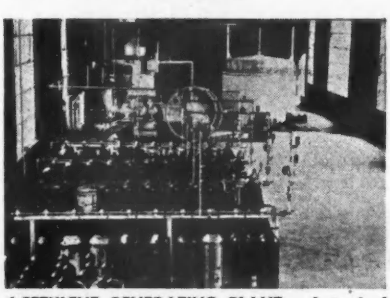
WE WERE called upon to design and build a portable Oxygen Generator. In a short time Independent Engineers completed the first Mobile Oxygen Generator capable of producing 99.5% pure oxygen and charging high pressure oxygen cylinders in the field.

There are now many of these Mobile Oxygen Generators supplying oxygen to our Armed Forces in all theaters of this war.

WE WERE also called upon to design and build a portable high pressure Hydrogen Generator. This was the first portable high pressure Hydrogen Generator capable of producing hydrogen and charging high pressure cylinders in the field.



OXYGEN GENERATOR—This is a view of a typical commercial Oxygen Generator installation in operation. This plant produces 750 cubic feet per hour and up of 99.5% pure oxygen.



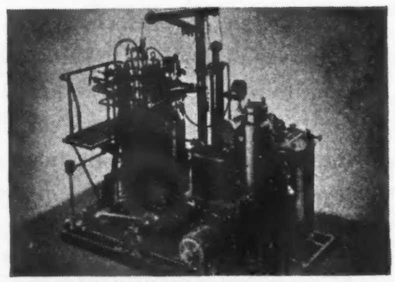
ACETYLENE GENERATING PLANT—A typical installation of our continuous generator and charging plant.

After Victory....

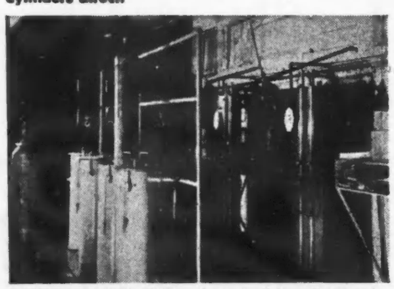
We will be building Oxygen and Hydrogen Plants for commercial users; also, Acetylene Generating Plants, High and Low Pressure Cylinder Testing Equipment, Acetylene Cylinders, etc.

We will be glad to go over your requirements and assist you in any way possible. If you are directly or indirectly serving the Armed Forces, it may be possible to obtain this equipment now. Address your inquiries to Sales Engineer, Department A.

INDEPENDENT ENGINEERING Co.
INCORPORATED
O'FALLON ILLINOIS



HYDROGEN GENERATOR—This is our compact Single Generator, High Pressure Hydrogen Plant. This generator produces 2500 cubic feet per hour of Hydrogen at 2500 lbs. pressure and charges cylinders direct.



TESTING EQUIPMENT—A typical installation for testing between 40 to 50 cylinders per hour in our testing department.

Carburs --- INDUSTRY'S FIRST CEMENTED-CARBIDE ROTARY FILES

Are Now Products of LINCOLN PARK

LINCOLN PARK Continues to Produce

- *Carboloy Gages*
- *Chrome Plated Gages —both New and Salvaged*
- *Steel Gages*
- *Small Precision Built-Up Gages*
- *Thread Plug Gages Salvaged by Chrome Plating*
- *Non-Cutting Precision Tools of Carboloy, Chrome Plate or Steel*
- *Carblox Cemented-Carbide Gage Blocks*

During the past year, Carburs have found wide acceptance among the country's leading manufacturers. These tools, the first of their kind ever to be produced, have proved their ability to offer at least fifty times the life of ordinary rotary files.

With the merger of Carbur, Inc. with Lincoln Park Industries, facilities are now available for greater and more varied production of Carburs. The experience gained by the Lincoln Park organization over a period of many years in manufacturing high precision inspection and production equipment now promises even finer quality cemented-carbide rotary files than were possible before.

At the present time, Carburs can be manufactured in shapes and sizes to meet almost any need. We'll be glad to supply you with full information.

ARMY (E) NAVY

LINCOLN PARK INDUSTRIES, INC.

Successor to The Lincoln Park Tool and Gage Company and Carbur, Inc.

1725 FERRIS AVENUE • LINCOLN PARK 25, MICHIGAN

The Machine of Tomorrow—
TODAY!

Sav-way SPITFIRE

ELECTRO-HYDRAULIC INTERNAL GRINDER

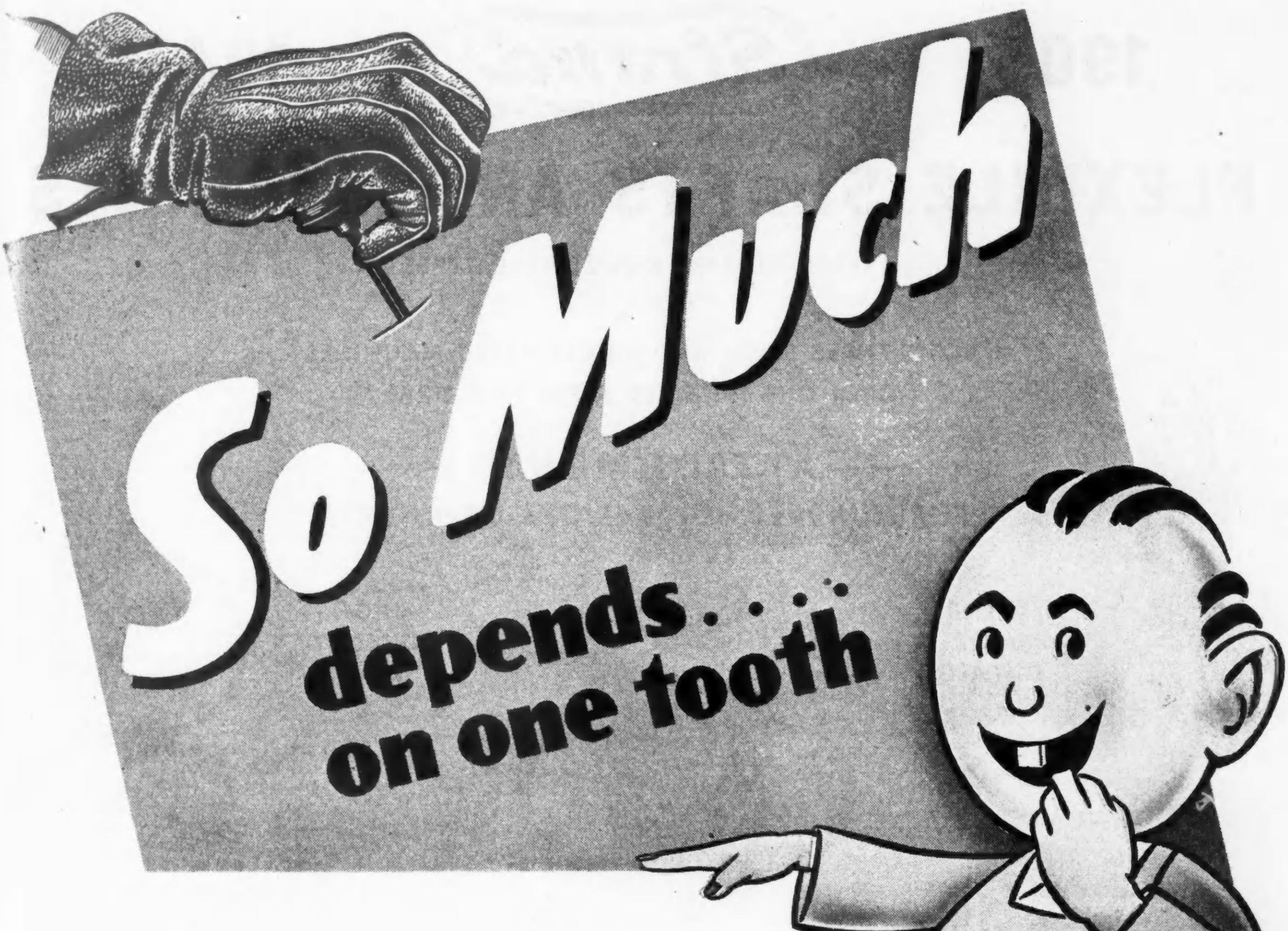
Modern Functional Design Throughout
★
Neoprene Insulated
★
Famous Gold Seal Spindle
★
Electrically-Operated Diamond Wheel Dresser

Ready ahead of time—the Sav-Way MH-1 combination hand and electro-hydraulic internal grinder. 5/32″ minimum table stroke! Gatling gun table speed, through the use of aircraft-type micro-limit switches and solenoid-operated valves. Electrical, automatic, adjustable cross feed. Dozens of outstanding features! It's a postwar machine—ready now to help speed today's war production! Its low cost will surprise you.

Sav-way INDUSTRIES
Machine Tool Division
BOX 117, HARPER STATION, DETROIT 13, MICH.

Send for Actual Photographs, Specifications, and Prices

BUILDERS OF HAND AND HYDRAULIC INTERNAL GRINDERS • PRODUCERS OF GOLD SEAL SPINDLES
PLUG GAGES • MICROMETER CHECKERS • PRECISION AIRCRAFT, AUTOMOTIVE, AND ORDNANCE PARTS



In designing a gear box, the engineer tests various shapes and sizes of teeth to determine what will be needed not only to handle the load efficiently but to provide an ample margin of safety. The engineer knows that, at best, only a few teeth can be engaged at one time and these may be called on to carry the maximum shock load. That's why the design of the individual "tooth" becomes so important. The present shape of the teeth in a Fuller gear is the result of a tremendous amount of research plus continuous field tests. You see the answer in the added wear-life . . . the smooth shifting . . . the quiet running of Fuller transmissions.

FULLER MANUFACTURING COMPANY, KALAMAZOO, MICHIGAN
Transmission Division
Unit Drop Forge Division, Milwaukee, Wisconsin

Fuller TRANSMISSIONS

"PITTSBURGH" DEVELOPMENTS IN AIRPLANE GLASS

New Glass Tempering Technique Saves Weight

THE PROBLEM: To supply laminated safety glass which could meet, with a minimum of weight, specified aerodynamic loads as well as internal pressures . . . and which, if fractured, would still provide satisfactory vision.

THE SOLUTION: A new technique for semi-tempering glass, developed by Pittsburgh Plate Glass Company, increases the strength of the glass 2 to 3 times, making possible a weight saving up to 50%. When fractured, laminated semi-tempered glass still permits satisfactory vision.

With many years of leadership in the making of laminated safety glasses for the automotive and other industries behind it, it was to be expected that Pittsburgh Plate Glass Company would become a recognized leader in the development and manufacture of airplane glasses. Today, the expansion of the aircraft industry has been reflected in the new processes, techniques and products developed by "Pittsburgh" for aviation use.

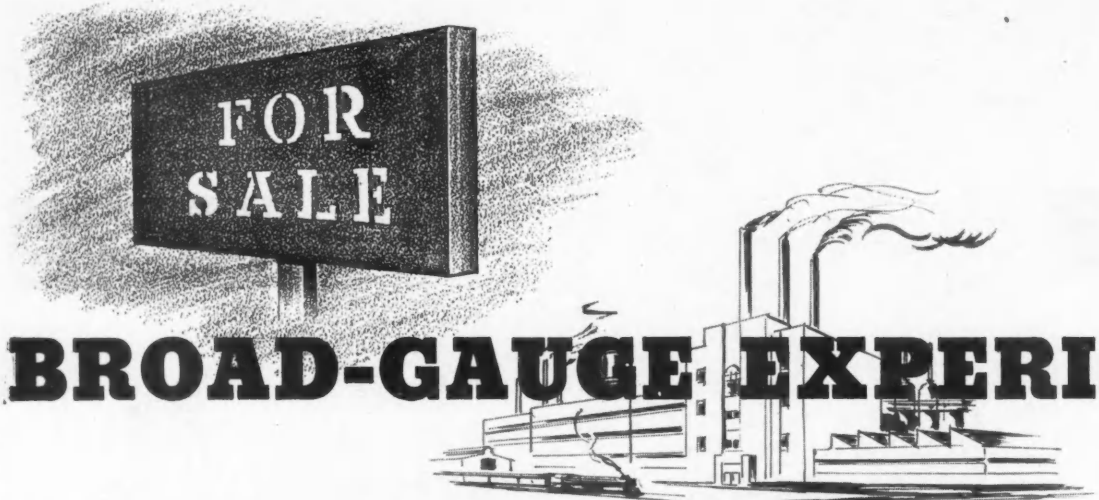
If you would like further technical data on any aspect of safety glass for airplane glazing, we invite you to write us on your business letterhead. Address Pittsburgh Plate Glass Company, 2099-4 Grant Building, Pittsburgh 19, Pennsylvania.

"PITTSBURGH" stands for Quality Glass and Paint

PITTSBURGH PLATE GLASS COMPANY

Specialists in Airplane Glass

MAKERS OF DUPLATE AND FLEXSEAL SAFETY GLASS AND OF MULTIPLATE BULLET-RESISTING GLASS



BROAD-GAUGE EXPERIENCE

in the manufacture of industrial rubber products

Extruded SHAPES

RUBBER *Bonded* TO METAL OR PLASTICS

Molded PRODUCTS

Hose

Lathe-Cut ITEMS

● The ill wind of war, like all ill winds, blows *some* good . . . for the pace of industrial research and production improvement is far higher in war than at any other time. In peace, we shall reap the rewards not only of victory, but also of industrial progress.

Rubber is a perfect example. If you have any idea that industry's uses of rubber, industry's ways of processing rubber, were at their peak upon our entrance into war, you are dead wrong. The developments of the past twenty-seven months have equalled those of the previous twenty-seven years. In many of them, Rodic Rubber chemists and engineers have pioneered.

These developments by Rodic are broad, basic, fundamental. They include successful new methods of bonding rubbers and synthetics to both metals and thermo-setting plastics. They include an astounding new time-saving process for the vertical molding of seamless tubing. They include many other short-cuts that can let you manufacture your war product today, and your post-war product tomorrow, faster and cheaper and better than you ever thought possible.

When your mind embraces the word "rubber", train it to add also the closely allied words "synthetics" and "plastics." We know the whole field—and our experience is at your command, along with our production facilities, geared up to produce fast and in volume.

Do you know *all* the ways in which we can make rubber serve you? Write, wire or phone us today!

For *Sealing Unlimited . . .*

SEALING *In*
GAS, OIL, HYDRAULIC FLUID

●

SEALING *Out*
DIRT, MOISTURE, AIR

●

SEALING *Against*
VIBRATION OR SHOCK

RODIC RUBBER
CORPORATION, Garwood, N. J.


THE CAR OF THE FUTURE
WILL NEED
SYNCHRO START
COMPLETELY AUTOMATIC PERFORMANCE
SYNCHRO-START
CONTROLS
AUTOMATIC CRANKING CONTROL
Automatic starting-stopping-protecting-controlling of automotive and industrial engines for the past twelve years.
Write for the new 1944 catalog.
SYNCHRO-START IS USED AROUND THE WORLD BY THE ARMED FORCES
SYNCHRO-START PRODUCTS, INC. 221 EAST CULLERTON ST., CHICAGO 16, ILLINOIS, PHONE VICtory 1495
SYNCHRO-START AUTOMATIC CONTROLS

Any way you figure it—if your trucks have special jobs to do they should be *special trucks*, engineered from bumper to bumper for their particular assignment. Such motor trucks do more useful work per day, at a lower cost, and with longer life.

The Ward LaFrance name on your trucks stands for equipment specially created by a manufacturer of highest standing, for the job it is intended to do.

Many users of stock model vehicles will be surprised to learn about the advantages which could be obtained from a specially engineered and built Ward LaFrance fleet. Investigate now — it's none too soon.

Heavy Wrecker M1

● A prime example of trucks built for the job, are the heavy wreckers being built by Ward LaFrance for the Army. They are used for tank recovery work and other recovery operations.

WARD LaFRANCE TRUCK DIVISION

ELMIRA, NEW YORK


Thread Milling Hobs-Unground
MULTIPLE SERRATION CUTTERS
Specially Developed
UNGROUND Thread Milling Hobs—as produced by MOTOR TOOL—are, within certain limits, matching the performance of GROUND HOBS. In fact, when limits permitted, we have made many that have out-performed the more expensive GROUND types. More pieces per grind. More grinds per hob.
In developing UNGROUND Hobs, it is vitally important to have the correct relief dependent upon work diameters—the degree of helical gash—the correct hardness for the metal to be threaded—whether internal or external threading.
Let us know the nature of the work to be done—the kind of machine in use—and we will design and produce UNGROUND Thread Milling Hobs that will show a marked saving in your tool costs.
BUY UNITED STATES WAR SAVINGS BONDS STAMPS
MOTOR TOOL MANUFACTURING CO.
METAL CUTTING TOOLS
7775 CORTLAND AVENUE · DETROIT, MICHIGAN
"Make it a Rule to Call Motor Tool"


Are you planning
New Materials
after the War?

On KENWORTH Army Wreckers, COMPAR-lined hose stands the gaff

ARMY wreckers built by Kenworth Motor Truck Corporation take tough terrain in their stride—just as the Resistoflex fuel lines on the engines take constant flexing and exposure to all kinds of gasoline.

For the hose has an inner surface of COMPAR, the unique elastic plastic that is glass-smooth though soft and flexible, completely impervious to gasoline—leaded or unleaded, straight or containing a high percentage of aromatics. COMPAR is non-swelling, non-sloughing, assuring free, full flow of fuel under the most severe conditions.

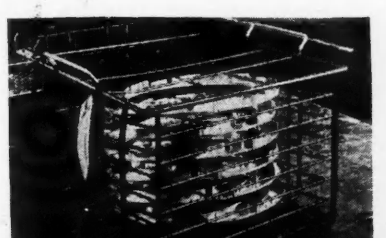
And the construction of Resistoflex hose provides maximum strength, while retaining the extreme toughness and flexibility of the COMPAR inner core. Resistoflex hose has exceptional resistance to shock loads, vibration and flexing.

This is just one of the many time-tested applications of Resistoflex hose on military trucks and similar equipment. For full details on the sizes and characteristics of hose and hose assemblies, write for the Resistoflex Industrial Catalog.

BASKET COATING PROTECTS PACKARD PARTS

Highly polished parts for Rolls-Royce aircraft engines move safely through the machining departments at the Packard plant in wire baskets coated with COMPAR—the *same* elastic plastic that gives Resistoflex hose its unique qualities.

Parts can be degreased right in the baskets, for COMPAR is immune both to oil and to degreasing solvents. Supplied by Resistoflex Corporation in solution form, the coating is easily applied in the user's plant. Write for further information.



RESISTOFLEX

HOSE AND HOSE ASSEMBLIES FOR HYDRAULIC OILS AND VACUUM, FUELS AND LUBRICANTS, ORGANIC SOLVENTS, PAINTS AND LACQUERS, THINNERS, REFRIGERANT, NATURAL AND MANUFACTURED GASES—LABORATORY TUBING—DIPPED AND MOLDED MECHANICAL GOODS—COATINGS, SOLUTIONS AND PROTECTIVE CLOTHING

RESISTOFLEX CORPORATION, BELLEVILLE, NEW JERSEY

Tests for Cutting Oils

(Continued from page 240)

were no visible changes, but the finish is found to be noticeably poorer after the point A than before it. Therefore, the point A is taken as the point of finish failure. For this cut tool life was 19.34 minutes and finish life was 7.15 min. When cutting with oil "C" the finish life was considerably longer than with dry cutting, although the tool life was nearly equal.

When the points of finish failure have been determined for each cut from the curves, the finish life can be calculated by multiplying the tool life by the ratio of the distance to finish failure to distance to tool failure. After the finish life is known for several speeds, the finish life is plotted against cutting speed on logarithmic paper. A straight line may be drawn through the points as is done with tool life points. The finish curve usually has a greater slope than the tool life curve, indicating that tool life is relatively longer compared to finish life as the cutting speed is decreased. As the tool life becomes very short the finish life approaches the tool life. Obviously, since the finish life can never be greater than tool life, the finish life curve can never cross or lie above the tool life curve.

Relative quality of oils may be somewhat different when finish life is used as a criterion instead of tool life. In finish life and tool life tests, the per cent increase in cutting speed with oil "A" over dry cutting at 30-min tool life was 8.3. The per cent increase in cutting speed with oil "A" over dry cutting at 30-min finish life was 17.5. From this it can be seen that oil "A" had a much better rating on a finish life basis than it did on the tool life basis.

For oil "B" the per cent increase in cutting speed over dry cutting at 30-min tool life was 23.7 and for oil "C" it was 27.2. When these oils are compared on this basis their performance is quite similar. However, when the comparison is based on finish life the performance of the oils is quite different. For oil "B" the per cent increase in cutting speed over dry cutting at 30-min finish life was 11.8, but for oil "C" it was 35.8. Obviously oil "C" is much better than oil "B" for finish cuts, but the tool life test did not show this rating to be so. In all cases the slope of the finish life curve was greater than that of the tool life curve. Oils producing good tool life are satisfactory for roughing cuts where finish is not important.

Another item of importance in cutting oils is the quality of the finish produced. Some oils produce a surface finish which is rough whereas others produce a smooth finish. A method was developed whereby the finish with oil could be compared with the finish with dry cutting. For this test we used the same type of tools as for tool tests and the same feed and depth of cut. Three tools were run with oil and three dry.

Each tool was run at five speeds for a short interval of time so that finish readings could be taken at each speed. The speeds were arranged in a different order for each tool so that the effect of wear, if any, was overcome. The first tool was run at speeds of 50, 100, 150, 200 and 250 fpm in that order. The second was run at the same speeds, but in the order 100, 200, 50, 250 and 150; the third run in the order 150, 250, 100, 50 and 200. The same sequence was used for both oil and dry cutting. It was necessary to have all the tools run at the same diameter and section of the test bar so that all the finish readings could be taken without changing any part of the setup. The readings for each speed were averaged and smooth curves plotted for both oil and dry cutting. The area between the curves was used as a means of classifying finish.

In addition to finish classification, which showed the overall performance from 50 to 250 fpm, another basis of comparison is called finish variation. This evaluation consists of five numbers representing the difference between the curves at the five speeds. In order to better visualize these data a graph is drawn with dry cutting represented by a straight line. This makes comparison between different oils easier because the shape of the dry curve is always the same and therefore does not influence the oil curves.

Additional tool life tests were run at constant cutting speed with varying side rake angles from zero to 40 deg. With a test of this type we expected tool life to be low for zero side rake and to increase as side rake increased up to a maximum, after which point the cutting edge would be weakened, thus causing the tool life to decrease again. We found this to be true except that with different types of oils the peak occurred at different angles. Oils containing high anti-weld in the form of active sulfur showed the best performance with low rake angles.

Some conclusions were drawn as to the practical application of cutting oils from this test. Active sulfur in an oil has the tendency to prevent seizure between the chip and the tool, but requires sufficient heat to perform that duty. Chlorine in an oil increases the strength of the lubricating film and has the apparent ability to keep the chip and the tool lubricated. If the pressure becomes too great the film will be ruptured, causing a condition of seizure to be present. We can say then that under light cutting operations where large rake angles are permissible that an oil should have a high lubricating quality. With heavy cutting operations where small rake angles are necessary the oil will be operating under greater heat and pressure and therefore should have a high anti-weld property. If active sulfur is present in an oil that is used for a light operation, it will act as an abrasive and decrease tool life. For this reason it is important to select the correct oil for each job.

British and German Aircraft Developments

(Continued from page 176)

announced that the Handley Page transport machine has a new and larger fuselage than the bomber, with a pressure cabin. The range is said to be 2000 miles with 50 passengers, which is akin to the capability of the Avro York. As a freighter, it is stated, the as yet nameless machine will carry 8 long tons over a range of 1350 miles.

The Ju 290 Four-engined Transport

The British Air Ministry has issued brief particulars, as follows, of the German four-engined transport aircraft, the Junkers Ju 290, of which a good deal has been heard of late, especially from the Russian front. A low-wing monoplane of all-metal stressed skin construction, it has twin fins and rudders, marked dihedral of the tail plane and double-wheeled undercarriage. The loading ramp is retractable into the bottom of the fuselage.

Armament of the Ju 290 consists of two 20-mm cannon (one in a dorsal turret and the other in the extreme rear end of the fuselage) and four lateral-firing machine guns. With a span of 138 ft it has a wing area of 2210 sq ft and is 92.18 ft long.

The four engines are of the BMW 801 L-2 type, a 14-cylinder two-row air-cooled radial developing 1500 hp at 18,000 ft. At that altitude the Ju 290 has a maximum speed of 243 mph. An over-water reconnaissance version of this machine is said to have been developed with an extremely long range.

Germany's Latest and Largest Bomber

The British Air Ministry has also issued some notes regarding the He 177, Germany's latest and largest bomber, which was first seen over England during a raid in January last, but which previously had been employed on long-range over-water bomber-reconnaissance duties. Reports from RAF night-fighter pilots indicate, as was expected, that the He 177 can be effectively dealt with by the Mosquito, despite the comparatively heavy defensive armament of the former.

It may be recalled that the He 177 is a mid-wing monoplane with a span of 103.5 ft. It has two DB 610 engines, each of which gives 2700 hp at 18,700 ft and is composed of two coupled DB 605 engines driving through a single propeller. (The DB 605 is the type of engine used in the Me 109G single-seat fighter.)

He 177s operating over England have been armed with a 20-mm cannon in a tail mounting and a number of guns

(Turn to page 426, please)

Small Size and Compact Design are Features of these Needle Bearings

•

REQUIRE LITTLE OR NO MORE SPACE THAN A PLAIN BEARING OF COMPARABLE RATING

•

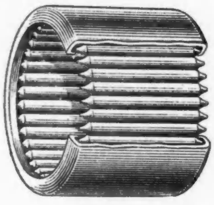
One of the outstanding advantages of Torrington Needle Bearings is their exceptionally small size in relation to their unusually high radial load carrying capacity.

The use of a full complement of small diameter rollers within a single retaining raceway—the basic design principle of all Torrington Needle Bearings—has provided the advantage of *anti-friction operation* within space limits no larger than required for a sleeve or plain bushing.

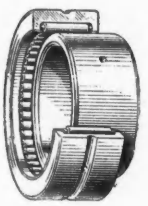
The small size which characterizes the Needle Bearing also contributes to efficiency and economy of product design in other important ways: it facilitates compact design; simplifies housing structures, frequently permits reduction in overall size; contributes to lighter weight; and through one or more of these advantages—makes for greater efficiency and lower cost.

Size Advantage in Newer Type Needle Bearings

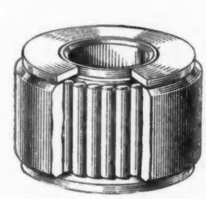
As one new application led to another, modifications were made and new type Needle Bearings were developed by Torrington to meet new engineering requirements which were encountered, particularly in aircraft applications. For example, the AT Type, originally developed for use in conjunction with AN bolts, has a heavy, through-hardened outer race, a heavy hardened inner race, and is designed to give a maximum static non-brinell capacity equal to the sheer strength of the AN bolt. Another type was designed to adapt the Needle Bearing principle to cam-follower service...another for "x-tra capacity" load requirements...and so on until today Torrington provides a Needle Bearing to meet virtually any radial load requirement. The size ranges of the principle types are shown in the accompanying table. Additional information on other types and sizes will be found in our Needle Bearing Catalog, available on request.



TYPE DC



TYPE NCS



TYPE AT

TYPE RC

TYPE NEEDLE BEARING	MINIMUM SHAFT DIAMETER	MAXIMUM SHAFT DIAMETER
DC	.1875"	3.500"
NCS	.6250"	5.500"
AT*	.1900"	1.000"
RC	.2500**	1.500**

*Size range to fit Standard AN Bolts Nos. 3 to 16

**Indicates OD of stud on cam-follower. Camroll diameters range from .6875" to 4.000".

Importance of Size in Postwar Product Design

War-accelerated design of military equipment and material which has shown a definite trend toward "compactness" to save cargo space and lighter weight to facilitate air transport will continue to promote greater efficiency in the design of postwar products. The contributions which Needle Bearings can make in this direction are already well established in many fields. If you are planning new products or design improvements in old, it will pay you to investigate fully the advantages in the use of Needle Bearings. Our engineering department will welcome the opportunity to cooperate in developing designs or assist in the selection of the correct Needle Bearing for your requirements.

THE TORRINGTON COMPANY

Established 1866 • Torrington, Conn. • South Bend 21, Ind.
"Makers of Needle Bearings and Needle Bearing Rollers"

New York • Boston • Philadelphia • Detroit
Cleveland • Seattle • Chicago • San Francisco
Los Angeles • Toronto • London, England

TORRINGTON
NEEDLE BEARINGS

of small caliber in dorsal, lateral and ventral positions.

Four Versions of the Me 323

It is stated in England that at least four versions of the six-engined German transport machine, the Me 323, are known to exist. It is flying with both three-blade variable-pitch propellers and with two-blade propellers of the wide-chord paddle-blade type. In addition, these two main types can be sub-divided into armed and unarmed transports. Photographic evidence is available showing each of the four variants. Presumably the unarmed versions are intended only for freight and passenger traffic inside Germany and the satellite states.

The span of the Me 323 is given as 187 ft and the internal capacity as 3530 cu ft. The maximum number of troops carried is said to be 130. This type of machine is known to have been used for the transport of fuel, oil, stores, water, troops, heavy and light gun trucks, tractors, stretcher patients, horses, motorcycles and light creeper track vehicles.

Engines of the Me 323 are Gnome-Rhone 14-cylinder air-cooled radials developing 965 hp at 13,000 ft, giving a maximum speed of around 170 mph at sea level. With a crew of five (two pilots, radio operator and two engineers) an outstanding feature is that the radio operator's cabin is actually inside the main spar of the port wing, while the engineers' cabins are located in the leading edge of the wing, one on each side for the control of the port and starboard engines respectively. Another unorthodox feature is the undercarriage comprising six rear main wheels and four small wheels housed in fairing along the side of the fuselage.

Training Films Speed War Production

An outstanding feat in the industrial history of the world, during a period when American industry established new standards of proficiency, was the rapid conversion of the automotive industry from peacetime production, with 1941 output of approximately 5,200,000 motor vehicles, into a vast arsenal in less than eighteen months.

One of the basic reasons for the success of this gigantic war effort, which finds parallel in aircraft construction, shipbuilding, metal orientation and allied mechanical endeavors, was the rapid adaptation of unskilled labor to specialized tasks. A major factor in this procedure was assistance from industrial training films sponsored by the U. S. Office of Education.

"Industry was faced with the colossal task of converting to war work and expanding its personnel to vast proportions," said J. W. Studebaker, U. S. Commissioner of Education. "Millions of men and women, for the most part without any industrial experience, had to be employed in war plants and taught to manipulate tools of production. The problem of mass training presented difficulties on a scale greater than ever had been met before. New and improved methods of imparting knowledge and skills had to be evolved to resolve the critical situation.

"As one contribution to the war effort, the U. S. Office of Education launched a program of film production to assist instructors in training the millions of new workers, and in improving the skill of those already employed."

The first series consisted of forty-eight films on subject of critical importance. The success of these sound pictures as training adjuncts was so great that they soon attained popularity in such allied countries as Canada, South Africa, Austraiia, England, India, Brazil and Mexico.

Now a second series is being released through the U. S. Office of Education and distributed by Castle Films, Inc., that consists of one-hundred and fifty 16 mm sound pictures. These are a continuation of the units shown in war factories. While there are 19,000,000 feet of this type of motion picture in use, it is estimated that one-hundred million feet will be in the service of projects devoted to war material and allied industries by the end of 1944.

Among training curriculums are applications of aluminum, aircraft technique, bombers, building a bomber, tanks, building a tank, shipbuilding, women in war plant work and salvage.

Included in the operation explanations are steel rule; micrometer; fixed gages; Vernier scale; height scale; rough turning between centers; turning work of two diameters; cutting a taper with the compound rest and with the taper attachment; drilling, boring and reaming work in chuck; cutting an external national fine thread; turning a taper with tail stock set over; cutting an extenrnal Acme thread; milling machine; cutting keyways; straddle and surface milling to close tolerances and straddle milling.

Many Jeep Engines Used by Allies

More Jeep engines are now harnessed to the United Nations' war effort than any other type of motor, regardless of size or weight, according to Ward M. Canaday, president of Willys-Overland Motors. The four-cylinder power plant is now being used in industrial war equipment as well as under the hoods of all quarter-ton scout cars in action with Allied forces throughout the world.

Although unable, for security reasons, to disclose the number of these engines that have been built into Jeeps since Pearl Harbor, the auto head gave an inkling of the tremendous output by stating that more than 50,000 alone have been turned out since that date for scout car replacements or independent power jobs.